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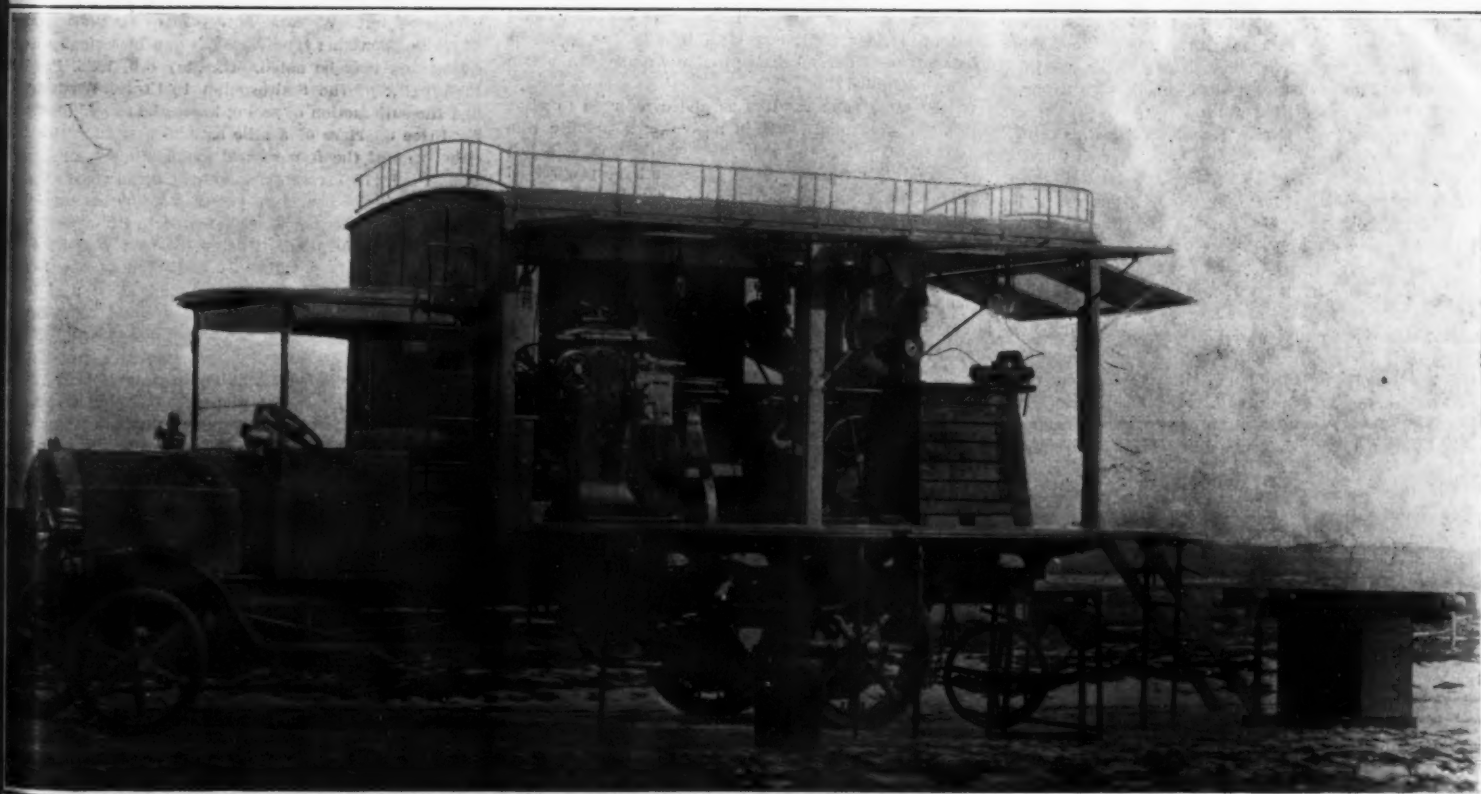
VOLUME LXXIX  
NUMBER 2042

NEW YORK, FEBRUARY 20, 1915

[10 CENTS A COPY  
\$5.00 A YEAR]



A motor truck for rescuing disabled cars.



A traveling workshop for repairing aeroplanes, automobiles, motorcycles and gun carriages.

AUXILIARY MOTOR CARS USED BY THE GERMAN ARMY.—[See page 116.]

# Aeronautics and the War\*

## A Review of What Aeroplanes Have Done and of Their Development During the Year

SOME time in the future—in the near future, we hope—it will be possible to review the aeronautical activity induced by the war as a whole, and to comment freely upon the facts then known to us. It is impossible and undesirable to do so at present. With the knowledge of what has been done, as possessed at present, we would be in some danger of drawing false deductions. Even now, we fear there is a tendency in some quarters to mistake the aim and object of the military aviator, a mistake fostered by the tendency of the Press to give undue prominence to certain dashing aeroplane exploits.

It is clear enough already that by far the most important duty entrusted to our flying corps is the collection of information concerning the enemy's movements. Time and again, Sir John French and others have paid splendid tributes to this aspect of our aviators' work. It has been definitely laid down as a guiding principle that this collection of information is to be the main object of the corps. Nevertheless, as the commander-in-chief said in a recent dispatch, almost every day new methods for employing the members, both strategically and tactically, are being discovered and put into practice. What these new methods are we will no doubt learn in good time. But for the present we must be content with the knowledge that in addition to collecting information our aviators are endeavoring, very successfully too, to prevent the enemy's airmen doing likewise. As a means for discovering targets for our artillery and for observing the range and directing the fire generally, they have proved themselves invaluable. In addition, it may be gathered that they are being employed to discover the position of our own troops and their movements and report accordingly to headquarters. This is, of course, not a very sensational occupation, but it is one of the results which can be of the highest importance, particularly under modern conditions of warfare. It is only fair to mention here also the admirable but wholly unsensational patrol work that is carried on unceasingly round our coasts by aeronauts of the naval and military wings.

While bomb-dropping has been effective against Zeppelin sheds, supply and ammunition depots, railway stations used by the enemy, and so on, it must not be forgotten that the effect is usually quite local, whereas the aeroplane scout may do work affecting the success of the whole campaign. Other methods of rendering the aeroplane a means of offence against troops have been suggested and tried, one notable case being the employment of it with a box containing steel darts for discharge against troops in close formation. We have seen and handled two forms of such darts. In one instance, the missile is merely a steel pencil, with a portion of its length fluted by a milling cutter to give it a tail. In the other case, the dart is more elaborate, consisting of a pointed ellipsoidal head, a small rod-like shank and a tail formed of four plane surfaces disposed at right angles. It weighs under 2 ounces, and during its descent probably reaches the limiting velocity of 400 feet to 500 feet per second, so that its striking energy is, say, about 500 foot-pounds. Reports from German sources, it is true—quite discredit the effectiveness of this weapon.

As for defence against aerial attack or observation, we may tentatively express the opinion that aeroplane is the best reply to aeroplane. Rifle fire from the ground is practically of no avail. Special anti-aircraft guns have been used and have on one or two occasions succeeded in bringing down their prey, but we have received no conclusive evidence to prove that they are an unqualified success. The aerial duel, romantic as it may sound, seems after all to be the most practical method, and in this connection it is highly interesting to note that according to reliable reports our officers seem to prefer the short service rifle and the revolver to any quick-firing gun yet designed or installed. Defence against Zeppelins falls under a different heading. The huge target presented and the slower speed probably render the anti-aircraft gun the best reply, although on this point we have had no real experience to guide us. Reports have been received on several occasions of Zeppelins being attacked by aeroplanes, and in at least one instance we were told that the aviator gallantly sacrificed himself and destroyed the enemy's craft by ramming it. Our readers should be slow to accept these stories as true. Indeed, Garros' exploit was a pure fiction. The operation would almost certainly not attain its desired end in the case of a Zeppelin or other airship possessing a rigid framework and carrying its gas in eight or more separate ballonets. A much more

reasonable and less wasteful method for carrying out an aeroplane attack on an airship is clearly indicated in the incendiary bomb.

It is not a little curious to turn back to-day to the "Aviation Memorandum" issued by the War Office in April, 1912. This memorandum, it may be recalled, definitely established the Royal Flying Corps on its present basis. One of the most striking points about it, as now seen, is the extraordinary estimate of the "wastage" likely to occur in war time in the ranks of the corps. The establishment for the expeditionary force was fixed at 182 flying officers and non-commissioned officers, with mechanics, transport, etc., additional. It was assumed that at the end of six months' war the wastage would be 100 per cent; that is to say, that the whole of the original force would be out of action. It has not, we think, been called attention to before, but the fact is that the casualties among the Royal Flying Corps have been remarkably low. We have now been at war for five months, and as correctly as we can discover our casualties have been as follows:

Army: Killed by the enemy .....	4
Killed accidentally .....	2
Missing and prisoners .....	5
Wounded .....	5
Navy: Killed by the enemy .....	2
Killed accidentally .....	3

In addition the naval air service lost two killed and three wounded when H. M. S. "Hermes" was sunk and suffered four wounded in transport and armored motor car work in Belgium. Counting all sources, therefore, the army has lost six and the navy seven of its airmen or mechanics. We do not know what the total aerial force attached to the British army or navy now is, but the *Gazettes* have shown us that since the war began the ranks have been enormously increased. We may doubt, therefore, if the casualties have amounted to more than 2 or 3 per cent. The figure is certainly very much smaller than that for the other branches of the army, so that it appears that the air service during war time is one of the safest to be in. This remarkable and significant deduction is, we may add, confirmed by the reports of some of our aviators, who frankly admit that from the point of view of safety they distinctly prefer flying to occupying a place in the trenches. Knowing all that they have done, their arduous duties, their daring exploits, could there be a finer testimony than this to the excellent construction of our machines and the skill with which they are handled?

In the same memorandum as above referred to some hesitation was manifested in assigning a definite rôle to the naval aeroplane and the organization was left correspondingly elastic. Since then we have progressed considerably. Seaplanes have been rapidly developed, and we have now a Naval Air Service that has been evolved along organized lines from the old naval wing of the Royal Flying Corps. Nevertheless the seaplane or hydro-aeroplane has not taken—or rather, has not been announced as having taken—any conspicuous part in the war so far. This is almost certainly due to the fact that opportunity to do so has been lacking. During the transport of the expeditionary force to France in August airships and aeroplanes—presumably seaplanes—kept watch and ward over the Channel for the approach of hostile craft. It is possible, too, that the aircraft that directed our monitors' fire against the German right on the Belgian coast included some seaplanes. Beyond this we have heard of nothing being done with these craft, although, of course, our seaplane bases round the coast have without doubt been engaged on useful patrol and other work. Our naval aviators have not, however, been idle. They have found a congenial occupation piloting land machines and armored motor cars. The raids on Cologne, Düsseldorf, and Friedrichshafen were all conducted by naval airmen. Still, these facts seem to lend strength only to the suggestion that the naval aeroplane for strictly naval purposes has a much more restricted field of application than its military sister. Indeed, when we read that during the twenty days preceding September 10th our military machines made daily an average of more than nine reconnaissance flights of over 100 miles each—and this may be taken as an indication of their activity since—the inactivity of the seaplane seems to amount in comparison to something approaching failure. In writing

\* These remarks were written before we received the news of the Cuxhaven seaplane raid.

thus we wish to express no final opinion, for we are well aware that we have not yet heard all that has been accomplished by our aircraft and that no final judgment can be passed on anything, let alone such a highly complex and technical subject as military and naval aeronautics until the war is well over.

### AERONAUTICS IN 1914.

Taking the question of general design, the year has witnessed several fairly wide departures from ordinary practice. While generally standard monoplane and biplane construction has become crystallized around a few departures of detail, there are signs that other possible types of flying machine are attracting attention. The helicopter idea, for instance, is not yet dead, as witness Mr. J. R. Porter's continued activity with his direct lifting parachute machine.

But to confine attention to machines following the aeroplane principle, we may note the construction at the Ponnier Works, in France, of a four-winged monoplane. The two pairs of wings in this machine are arranged in tandem, the front pair having a dihedral angle between them and securing lateral stability, and the rear pair being vee-shaped in plan, as in the Dunne machine, and securing longitudinal stability. Fitted with a 70 horse-power Gnome engine, this machine, under test at Rheims, is said easily to have lifted a useful weight of 1,400 pounds.

As is well known, M. A. V. Roe and some others in the early days spent considerable time experimenting with triplanes. Although complete failure did not result, at least in Mr. Roe's case, the idea was generally abandoned. It is difficult at the best of times even now to combine structural strength in a biplane with non-interference of one wing on the other. Still more so must it be in the triplane. Yet as the loads to be carried increase a time will soon come when the biplane formation will result in an impracticably great span and resort will have to be made for purely constructional reasons to the triplane or other formation. It is therefore interesting to note that a successful triplane machine has been demonstrated during the year. This is the Euler hydro-triplane or flying boat, manufactured at Frankfurt-on-Main. The top plane of this machine has a span of 46 feet, the middle of 33 feet, and the lower of 26 feet. The three planes, to avoid interference, are very much staggered, the top plane considerably overshooting the middle and the middle the lower. The machine is propelled by a 100 horse-power Gnome engine. We have no record of its performance.

While discussing type variations an historically interesting fact may be noted. On May 6th, 1896, Prof. S. P. Langley of the Smithsonian Institution, Washington, had the satisfaction of seeing his model aeroplane flying for three quarters of a mile against a wind. This machine was of the four-winged monoplane type and was propelled by two screws driven by a steam engine weighing 6½ pounds per horse-power. A subsequent large-sized copy of this machine, intended to lift a pilot, was constructed, but failed. During the past year an exact duplicate of this machine as preserved at the Smithsonian museum was constructed and fitted with a 60 horse-power Curtiss motor. With a slight reduction in the angle of incidence of the wings and the addition of a hydroplane for starting an American aviator, in September, succeeded in flying it nearly 2,000 yards. Langley's position as a pioneer of flight, sometimes doubted, has thus definitely been established.

Leaving the development of type for the development of detail, we can touch only upon one point, namely, the vexed question of stability. The progress made in this direction has not been as great as we should like to see. It is undoubtedly that so far as automatic stability is concerned, there is a prejudice against it among pilots, and that this prejudice is hindering progress. They object, it seems, to carrying more machinery than is absolutely necessary, and looking at some of the complicated and delicate devices which have been proposed for attaining automatic stability, our sympathies are entirely with them. They maintain, too, that no device yet proposed secures stability under all conditions, and that at times, notably when landing, the stability must be under the direct personal control of the aviator, with the intervention of the least possible amount of machinery.

The Sperry gyroscopic stabilizing device has already been described in these pages, and may be taken as typical of many proposals. Equally typical of another class is the Wright system, to which much attention has been directed during the year. In this the controls are arranged to be operated by a compressed air motor.



The action of this motor is in turn controlled by a vane when the longitudinal stability is upset and by a pendulum when the lateral stability is affected. The use of a pendulum for this purpose has often been proposed, but it is unsatisfactory because of the tendency of the pendulum to swing to its maximum amplitude independently of the magnitude of the displacement to be

corrected, and to keep swinging when the machine has been righted. In the Wright apparatus an electrical contact system is employed to correct these deficiencies.

As for inherent stability, progress toward a completely satisfactory solution is still in the experimental and mathematical stage, although, of course, there are many machines in existence which give a fair degree

of inherent stability under certain conditions. The ordinary dihedral angle between the wings of a machine is intended to secure partially at least inherent lateral stability. As a development of this, we now have, as in the Curtiss system, a stabilizing disk, with its lateral edges turned up, mounted well above the upper main plane.

## The Making of Large Guns

### Some Details and Methods of Constructing Modern Weapons

THERE has been so much in the daily news reports about the "big guns" and what they do, that there is a natural curiosity among a large element of the community to know how these remarkable weapons of modern warfare are constructed. To such the following description of the methods of procedure in building of big guns in England, which we find in the Engineering Supplement of the London Times, will be of interest.

From the point of view of the machinist the manufacture of ordnance has three aspects—the large numbers required, the peculiar and special shapes of many portions, and the exceedingly fine degree of accuracy which is absolutely essential. The large numbers required affect the methods of manufacture adopted. There is, of course, an immense difference between the numbers in which the smaller artillery and the relatively few big naval guns are built, between say, the Maxims and the 12-inch or the 15-inch guns. Yet for all alike the shop methods adopted are those which are now generally recognized as processes in which jiggling and gaging are essential. When in war a piece of artillery is thrown out of action by the removal or damage of some essential part, it is of the first importance that it shall be renewable without the help of the skilled mechanic. This involves a degree of refinement in measurement which exceeds even that adopted in ordinary engineering works. The highest grade of interchangeable practice is therefore essential to insure the best results; and all the methods which are available to secure those results are freely used—jigs, special drills, boring tools, reamers, cutters, and gages and micrometers. Even when parts have to be finished by hand they are checked and tested by means of fixed gages. Any part of any one type and size of artillery will then take its place in any individual of that type and size.

Again, the peculiar and special shapes of many portions have been the cause of the design of many special machine tools which are used for no other purposes and the details of which are not permitted to be published. Probably one half the tools are either of this character or else they are standard designs greatly modified. In many cases two or more operations are done on the same piece simultaneously. The accuracy required involves not only the jiggling and gaging already noted, but also a most elaborate system of testing before the various components are passed to the assemblers and erectors. This work is done in special shops by skilled men who are provided with very delicate instruments and appliances.

#### METHODS OF BUILDING-UP.

Ordnance in this country is constructed by reinforcing the actual gun tube with rings shrunk on. Two systems are in use, one with, the other without, wire winding. The latter is reserved for the heavier guns and chiefly for naval service, and it affords a very refined method of securing annular increments of tensile strength corresponding as nearly as possible with the stresses which are imposed by the discharge. The wire also reinforces the gun tube so that in most cases the tube will safely endure the enormous stress of 17 tons to the square inch. The steel in the wire is of about double the tensile strength of that in the tubes. The difficulties of shrinking on tubes to secure uniform stress, even though they are divided up into comparatively short lengths, are greater than those of winding wire. If the tube should crack or develop a fault it may still be fired. In the event of an explosion of a shell in the tube the wire winding will prevent grave disaster. A faulty tube can be more readily replaced when wire-wound than when the gun is built up solidly. The illustrations give sections through the two types of guns. The solid gun is seen to be built up of tubes wholly. These are clearly shown, and the jacket, each one shrunk on its predecessor. In the wire-wound gun there may be one or two tubes over which the wire is wound, and the jacket tubes are shrunk over the wire. A bush for the breech plug is screwed into the rear end, which is also reinforced by a breech ring outside.

#### MACHINING OPERATIONS.

The enormous stresses endured by the built-up guns would not be possible but for the extreme care exercised in the preparation of the steel and in the heat

treatment—the annealing and hardening to which it is subjected. The steel is melted in open-hearth furnaces and the metal is poured into solid octagonal ingots. The first machining operation is that of trepanning or boring a hole through the ingot, and is preparatory to the forging. For large ingots the boring bar is rotated, but small ingots are rotated round a bar which does not rotate, but is fed forward. A mandrel is thrust through the hole, while the tube is worked under a hydraulic press to diameter and length. The mandrel is hollow to permit a stream of water to be forced through it to keep the central part cool. Rough turning and boring follow. The largest lathes are used for the gun tubes. The lengths vary with the size and class of gun. The beds range up to 90 feet and sometimes more in length, and height of centers varies accordingly. Generally these lathes have two saddles. They are driven by independent electric motors. Rough boring is

chining of the keys for the slides of the mountings and the lugs for the breech-block hinge follows.

#### RIFLING.

The rifling of the bore succeeds, and is done in machines designed for that purpose only, the bar being traversed and rotated to synchronize with the pitch of the grooves. The rotary movement is effected by a pinion on the end of the bar turned by a rack, which is actuated from a templet bar. In long rifling change-gears would be impracticable. In the subsequent examination the accuracy of the bore and rifling is tested by inserting plastic gutta percha. The interior is illuminated with mirrors to detect defects, if any. The exterior is examined while the guns are rotated on roller bearings.

#### CONSTRUCTION OF THE MOUNTINGS.

Yet the manufacture of the gun tube is comparatively simple from the aspect of machine operations when

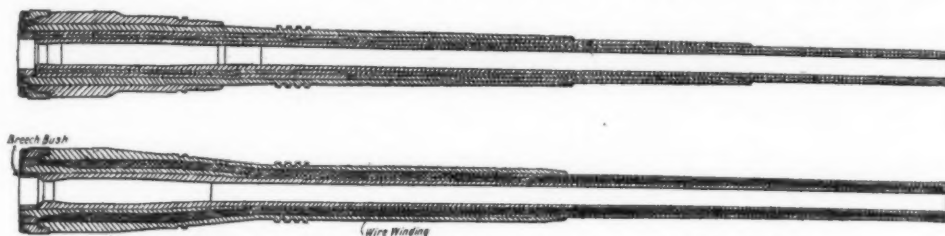


Fig. 1.—(Upper) Gun built up of steel tubes. Fig. 2.—(Lower) Wire-wound gun.

done on other machines, the beds of which are long enough to permit of boring from each end simultaneously. Similar operations are performed on the gun tubes and the jackets, but on different machines, each of a length and height of centers suited to the particular work put upon it. In some machines two tubes will be bored simultaneously. An important operation follows, that of hardening or tempering in a bath of oil. The resulting hardness and tensile strength have to pass strict specified tests before any more work is done.

#### WIRE-WINDING.

From this stage the guns are constructed on one of the two systems named, that of plain tubes and jackets, and that of tubes wound with wire before the jackets are shrunk on. The tube is rotated in a lathe, and the reel off which the wire is wound is mounted on a carriage that is traversed along a bed at the front of the lathe bed proper by means of a screw regulated to synchronize with the rate of revolution of the lathe. The wire is secured at the breech end by being wedged in a recess, after which the winding proceeds along to and fro alternately. To vary the tension that is put on successive layers the wire is nipped between dies of hardened steel pressed in contact by a series of levers and weights adjusted to suit the varying tensions. The tension is diminished in each successive layer. The windings are least at the muzzle and greatest at the breech; in a 12-inch gun they number 12 and 75, respectively. The wire is flat—of ribbon section—about  $\frac{1}{4}$  inch wide by  $\frac{1}{10}$  inch thick. Its tensile strength is very high, 100 tons to the square inch. A 12-inch gun requires 117 miles, with a total weight of about  $13\frac{1}{2}$  tons.

necessary to remove inequalities in readiness to receive the jacket tubes, which are bored to be slightly smaller than the outside of the wire, so that they may be shrunk on. In a tube which is not wire-wound the same process is adopted.

When the inner tube consists of two portions, the inner one is slightly tapered on the exterior and also provided with a number of shallow shoulders. The interior of the second tube is bored to correspond with a diameter very little less than that of the one over which it has to be shrunk. It is then heated slightly and the inner tube thrust into it up to the shoulders.

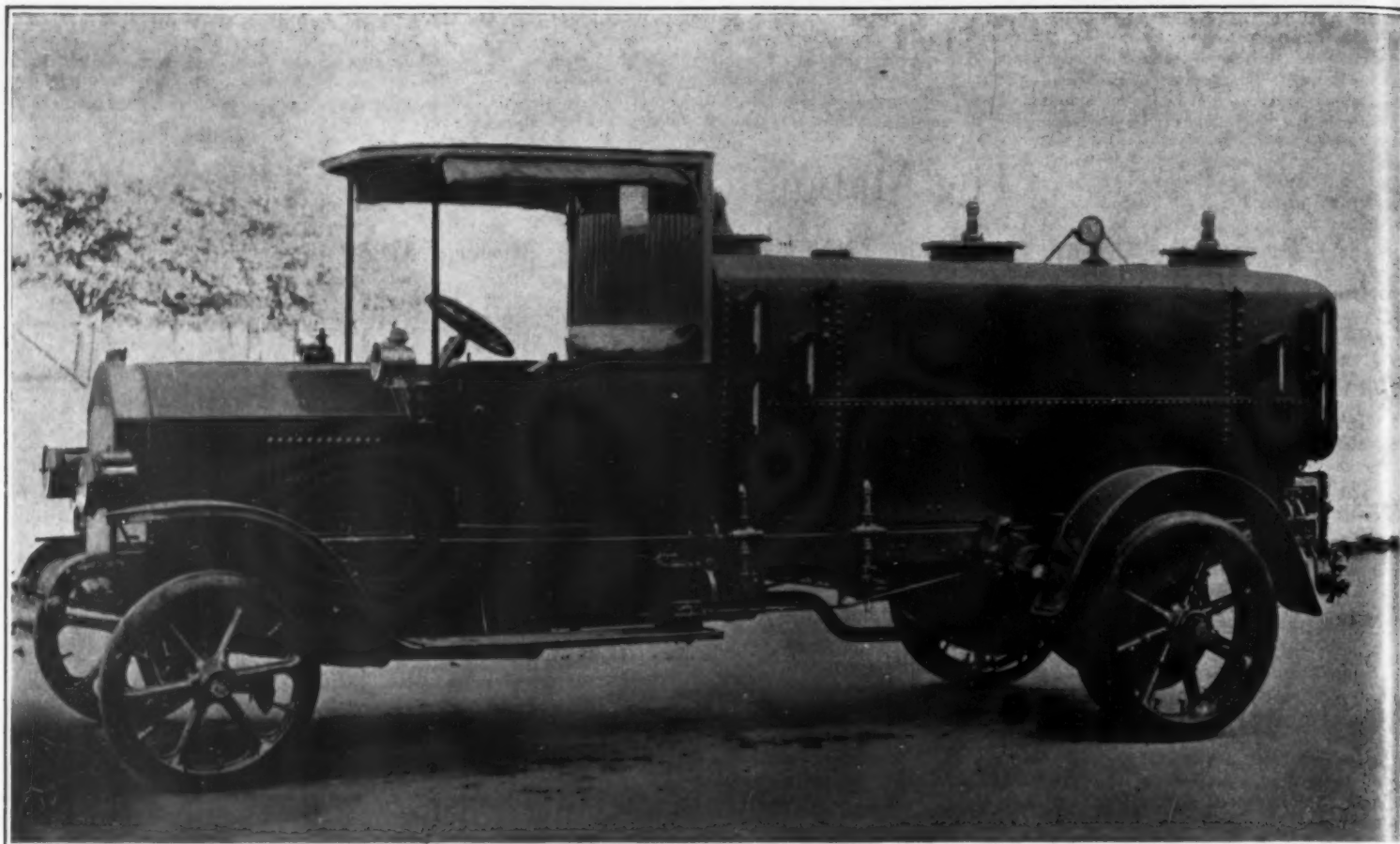
As these shrinking-on operations have to be done with the guns suspended vertically, very deep pits are necessary, partly sunk into the ground and partly built up about it. The heating is effected by gas jets surrounding the jacket. Water taps are provided for use if required for cooling. After the shrinking on is completed the outside is skimmed over in the lathe, and the ma-

compared with the component parts of the gun mountings. Excepting in their proportions and dimensions and the differences in wire-winding and building up without wire there is no essential difference between the small and the large gun tubes. All are built up, all are breech-loaders. But the mountings are totally unlike in land artillery and naval ordnance, and in small and large guns. In a Maxim there are about 280 separate parts, entailing about 550 distinct operations done on machines, apart from the fitting. For the 0.303 Maxim about 950 gages are used and the parts—all interchangeable—are within the limit of  $\frac{1}{5,000}$ th part of an inch. On a 6-inch gun there are about 100 parts in the mechanism of the breech alone. The work on the pom-pom gun involves about 770 operations by machine tools done on 400 parts. The amount of tooling entailed on some pieces reduces the weight by one half or more. The lock frame for this gun weighs as a drop-forging  $25\frac{1}{2}$  pounds, but only  $10\frac{1}{2}$  pounds when finished. Some parts require 27 distinct milling operations, each one being tested by gage.

The breech of a gun is a marvelous piece of mechanism, most of the machining of the parts of which is done on special machines. The bush and the block are prepared from forgings long enough for some twenty pieces to be cut from it, and these are hardened and subjected to tests before any actual work is done upon them. Hardness and strength are essential for two reasons—one to offer the maximum resistance to the stresses of discharge, the other to lighten the parts as far as is consistent with safety. All the movements of the block are accomplished by the movements of a single lever in the smaller guns, of a handwheel in the larger, by means of mechanism contained in and about the block, and this detail is a vital element in the quick firing of guns, the importance of which is well understood in modern warfare. Another aspect is lightness.

#### QUICK-FIRING AND AUTOMATIC GUNS.

All guns now are quick-firing, but relatively few are automatic. The distinction is this—in the first the breech is opened and closed by lever or hand wheel with remarkable rapidity, in the second the energy of the recoil operates the mechanism. In England the Maxims and the pom-poms are the examples of this latter group. In these the breech-block is not screwed, but slides in a vertical plane between guides, a spring and a lever operating it alternately. The pom-pom will fire from 250 to 300 rounds a minute. Each shell weighs about  $1\frac{1}{4}$  pounds and bursts into a dozen pieces. The Maxim will fire 800 rounds a minute, and its projectile weighs 1 ounce. A 6-inch field gun carries a 100-pound projectile. A 12-inch naval gun fires an 850-pound shell, a 15-inch gun one of 1,950 pounds.



Fuel supply tank car for motor transport service.



A rescue car with sides fitted, and a car for carrying parts for replacement.

## Auxiliary Military Motor Cars

### Various Kinds of Cars That Have Been Developed to Meet Requirements of Armies in the Field

THE German army department, in conjunction with the Benzwerke Gaggenau, have designed a number of military vehicles which on account of their special utility are of great importance. These auxiliary motor cars are kept at the instant disposal of the army in order that in the event of any breakdown of other motor vehicles they can immediately come to the rescue, and they also serve to replenish stores of fuel, oil and water.

Their duties also include keeping the military vehicles of all classes in permanent working order. These cars each comprise a Benz chassis with such alterations and additions as are required for the special purpose for which each is intended. Each machine is driven by a 44.50 horse-power four-cylinder motor, and extra large radiators are fitted, so that even when

the vehicles are stationary there is sufficient cooling effect for continuous running of the engine.

There is a motor-driven tank wagon provided for the transport of supplies of fuel, water and oil, and the tank therefore is divided into three compartments. The front and rear compartments contain respectively oil and water, the large central chamber being reserved for gasoline. The gage glasses and a gasoline meter show the amount available in each compartment at any moment, while pumps are fitted by means of which the contents of each compartment are conveyed through flexible hose pipes to the cars requiring replenishment.

As shown in an accompanying illustration, another motor-driven military car has been designed intended for the transport of a complete stock of replacement parts including tires. The tires and larger parts are

carried in a central compartment, while the smaller articles are stored in bins on either side of the vehicle. Each bin can be locked, while a special device enables all bins in any row to be closed and locked simultaneously.

There also has been developed another auxiliary motor vehicle intended for carrying bodily a car which may be temporarily disabled, thus preventing its capture by the enemy. This vehicle has an exceptionally long wheelbase and frame to take an extra long platform body fitted with removable sides about 20 inches high. These sides are each fitted with a folding truss, and can be used to form ramps up which a disabled vehicle can be rolled onto the platform. This operation can be performed with little loss of time, as the rescue vehicle is provided at the rear with a winch



(driven by the power of the engine) from which a steel cable is attached to the disabled vehicle. The platform of the rescue car is also so equipped that a crane can be installed and utilized for picking up a vehicle that may be too seriously disabled to be hauled up the ramp as described above.

The military workshop car shown in one of the illustrations is of the greatest importance for the keeping in order of aeroplanes, military motor-cycles and gun carriages as well as other motor vehicles.

As will be noted in the photograph, a complete outfit

of machine tools and appliances has been installed on the car, comprising a lathe, shaper, hand saw, a smith's furnace and anvil, a machinist's bench, a carpenter's bench, and a grinding machine. At the rear end of the chassis is installed an entirely inclosed direct-current dynamo with an output of 6.6 kilowatts, and driven from the gear box of the vehicle by means of a special shaft and clutch. This dynamo supplies the current to the individual electric motors fitted to each of the machine tools. The shop is also electrically lighted.

It may be stated that the walls of the shop are divided longitudinally and the lower halves are provided with adjustable legs, thus providing additional working space; while the upper halves of the sides furnish shelter. A rail fitted round the top of the roof furnishes additional storage for material. With the equipment here described the various fighting machines of the army may be kept in working condition in the field, when without such traveling workshops much of the military apparatus when once disabled would be useless or have to be abandoned.

### The Preserving of Food Products\*

MILLIONS of dollars is a lot of money. When invested in perishable foodstuffs, the market value of which fluctuates, and supplying the most densely populated section of this continent, the problem of preserving these products is one of great economic and engineering importance. We will consider only the engineering part of the problem.

Right here, the writer wishes the reader to understand that in this plant uninterrupted service is paramount. To shut down is unthinkable.

Service is sold on a guarantee that the temperature will not vary more than one degree. Suppose the plant fails only for a short time in summer; then the tem-

perature rises and hundreds of thousands of dollars' worth of produce may be ruined. The dealer can claim damages for his loss, and there is always the possibility that, should the service fail and the temperature rise considerably at a time when the market value of the produce is going down, with every indication that it will not rise soon, the dealer might sue, claiming injury to his produce, and thus try to recover a loss or avoid an impending one. Where over 800 customers are served on the street system alone and seventeen large warehouses are filled with perishable goods, as is the case in a large plant in Boston, the damages due to service interruptions would be large.

Service interruptions are as much to be feared as in electric central-station or railway practice, either of which can drop its load and pick it up where it dropped it. A refrigeration station cannot do this. The moment service ceases, the temperature begins to increase,

and by the time the plant is again in service, the temperature may have risen so high as not only to damage the goods, but—and here is the point—to require hours to get it back to normal.

Differing from electric or railway station practice, the load is practically constant 24 hours a day for whole seasons. From the viewpoint of overall station economy, this may be desirable, but where real estate values are high and the station's capacity is none too great for the maximum demand, the equipment must go into service prepared for a nonstop run of months. Every feature of operations, every detail of design must be planned to this end, and should an accident occur, the exigencies demand that the crew be capable of getting the machine back into service with the least possible delay, which means that it must be, to a great degree, independent of outside aid except for very exceptional cases.

\* From an article on the Equipment and Methods in the Largest Refrigeration System, by Charles H. Bromley, in *Power*.

## High Explosives in Warfare\*

### Interesting Facts Relating to Their Composition and Action

By W. Macnab

AT the present time explosives are playing such a prominent part in the war that the interest and attention of the most peace-loving citizen are necessarily aroused by the terrible results undoubtedly produced, or are more morbidly affected by the tales of the alleged marvelous effects which are yet to be experienced. A few notes on the most important explosives being used in war may therefore be of special interest just now.

The explosives which can be advantageously employed in warfare are by no means the most powerful which the chemist can produce, or which may even be used in civil engineering or mining operations. The military high explosive must be sufficiently insensitive to shock to prevent its being exploded when struck by projectiles, or when submitted to the shock of being fired from a gun as the charge of shell, else it might prove as dangerous to the user as to the enemy. Thus, the nitroglycerine class and many other explosives are excluded.

For many years guncotton, containing a considerable amount of moisture, was largely used for naval and military purposes. In the moist state it is extremely safe, but can be easily detonated when a small primer of dry guncotton is fired in contact with it. The explosive effect is great, and it provided an excellent and safe explosive for military mines and purposes of destruction, and as a charge for torpedoes. It was not, however, suited for use in shells.

The high explosives chiefly being used in the present war for shell-filling are picric acid, trinitrotoluol, and ammonal. Picric acid, with or without the admixture of various ingredients, has been in use at one time or another in most countries under the names of melinite, lyddite, shimose powder, etc. Until picric acid came into use, black gunpowder formed practically the only explosive used as a bursting charge for shells, and the use of picric acid was a great advance from the destructive point of view, as its explosive power was very much greater. Picric acid, although sufficiently insensitive to shock, has the property of readily attacking metals and forming picrates, which are much more sensitive and liable to explosion. This involves special precautions in dealing with it, and is a disadvantage.

Ammonal is a mixture consisting of ammonium nitrate, trinitrotoluol, charcoal, and aluminium in fine powder. It is very safe, and is more powerful than picric acid, but owing to the hygroscopic character of ammonium nitrate, its chief constituent, it has specially to be protected from moisture, which reduces and, if in sufficient quantity, destroys its power of explosion. It is largely used by the Austrians.

Trinitrotoluol is undoubtedly now the most widely used high explosive for military purposes under the names of "Trotyl," "Tritolo," "Trolite," "Tritol," "Tritite," and "T.N.T.," according to the nation using it.

"T.N.T.," as it is called in the British Service, has

attained its position by virtue of its merits. It is used in a state of great purity; it is chemically stable and without action on metals. It is unaffected by water, and can be fused and run into shells in the molten state. It is less sensitive to shock than picric acid. Hard blocks of suitable size and shape are covered by electroplating them with a coating of copper, which prevents the blocks from being broken and having their edges chipped. In this form "T.N.T." is used for demolishing bridges, etc. Although not quite so powerful as picric acid, its other advantages make it at present perhaps the best available explosive for military use.

The destructive effect of an explosion is caused by the almost instantaneous conversion of the solid explosive into gases, at a very high temperature, with consequent sudden exertion of an enormous pressure. From the purely disruptive point of view, the composition of the gas produced is not necessarily of importance, the determining factors being the volume of gas, the heat produced, and the velocity of detonation. When, however, an explosion takes place in a confined space, then, in addition to the disruptive or shattering damage, the components of the gas produced may have an injurious effect on anyone having to breathe it.

In the case of explosives for use in civil life, as in mining work, care is taken by adjusting the composition of the explosive that the gases produced shall not have a deleterious effect on the miner. In military operations this consideration does not arise; indeed, it may be maintained the more deadly the effect of the fumes the better.

Picric acid and "T.N.T." are definite chemical bodies, but owing to insufficiency of oxygen are not completely converted into gas on explosion, a considerable amount of carbon being set free. This accounts for the black smoke which is seen when these bodies are exploded.

In the earlier determinations, when explosives which contained insufficient oxygen for complete oxidation of the carbon and hydrogen were fired in a closed bomb, and the resulting gas analyzed, it was found that its composition was affected by the density of loading. The higher the density of loading the higher the pressure, accompanied by increase of carbonic acid and decrease of carbonic oxide. Methane, which was absent or only in very small quantities at low densities of loading, increased steadily as the pressure increased. It was, however, recognized that the composition of the gas so found did not necessarily represent the composition at the moment of explosion, for the analysis was made some time after and when the gas had cooled. Consequently reactions had probably been taking place during the process of cooling. Finally, it was thought that the formation of methane was not a real result of explosion, but was due to secondary reactions during the cooling stage. The experimental difficulties of catching and fixing the gases at the moment of explosion were overcome by detonating the explosive in its own volume

in a lead or porcelain bomb placed inside a larger evacuated steel bomb. The explosive had in this way to do work in bursting the smaller bomb, and the rapidity of cooling of the gas was thus so greatly increased that secondary reactions practically did not take place. When fired under these conditions, which correspond closely to those which exist when a shell explodes, the gases from ammonal, picric acid, and "T.N.T." were found to contain only small quantities of methane. In addition to carbonic acid, nitrogen, and hydrogen, ammonal contained about 24 per cent, and picric acid and "T.N.T." nearly 50 per cent of the poisonous carbonic oxide. It is thus evident that where shells burst in confined spaces, in addition to the damage caused mechanically, those persons breathing the fumes may be fatally poisoned or seriously effected physiologically.

It has been suggested that the ingredients of shell charges may contain deadly poisons, but it seems improbable that any poison intentionally added to the contents of a shell would retain its toxic properties after the shock and heat of explosion. As seen above, the gases from the explosives now in use may be sufficiently poisonous under certain conditions.

The subject of explosives seems often to create a state of credulity, and to generate extravagance of statement on the part of the non-expert writer rarely effected by other matters. The unknown sometimes becomes truly appalling under his imaginative pen. Even inventors have been known to make wild statements in regard to their explosives! One should only accept with very many grains of salt the sensational statements which have appeared in some quarters as to the weird and deadly effects of recently invented explosives. It is well, therefore, not to have exaggerated ideas of the power of explosives or to be unduly scared by the threat of explosives dropped from Zeppelins. The destructive effect of the large charges which can be fired from the huge howitzers used in the present war is terrible, but explosives have their limits.

While without doubt the damage done locally from the explosion of a large quantity of any explosive which might be dropped by a Zeppelin would be appalling enough, yet, judging from the effects of the accidental explosion of a couple of tons of nitroglycerine during manufacture, its area would be comparatively restricted, and the horrifying suggestions mooted of the coming total destruction of cities by explosives dropped from the sky may be ascribed to the imagination of the over-credulous.

**Winter Wireless News Service to the Magdalen Islands.**—These islands lie in the middle of the Gulf of St. Lawrence, and the inhabitants have no mail, and hence no newspapers, during the winter. Accordingly the Canadian government is sending a wireless dispatch of 800 words weekly to the clergy of the island, giving the latest news of the war and other events, to be communicated to the islanders on Sundays.

\* From *Nature*.



# Training for the Municipal Service\*

How Public Business is Conducted Efficiently and Without Waste in German Cities

By Clyde Lyndon King<sup>1</sup>

"We have conquered upon the field of battle in war; we are now conquering upon the field of battle in commerce and industry." Such was the watchword which Crown Prince Friedrich gave to Germany at the inauguration of the Museum for Industrial Art in Berlin the day after the treaty of Frankfurt, closing the Franco-Prussian war.<sup>2</sup> And Germany has conquered in commerce and industry. One reason for this conquest is that her schools have adopted in effect the standards recently set by the South German Educational Congress: "The state must aim at the diminution of commercial waste by insuring that all occupations, however mean, shall be practiced by men who have been trained to do their work scientifically." After diminishing waste in the occupations, German efficiency is now doing away with waste in the public's business due to inadequately trained and improperly equipped public officials and employees.

Four factors may be singled out as being responsible for the tendency toward sustained and thorough, yet specialized and practical, preparation for municipal service in Germany.

The first of these is the rapid rise in urban populations. In ten years the population of cities of over 100,000 increased 50 per cent. Half of the German population are now urban residents. This enormous increase in urban populations means an increase in public functions assumed by city governments many times greater than the increase in population. This increase in public functions requires efficiency and training of public employees.

Preparation for governmental positions in the state has been provided for in the state universities. These institutions are under the domination of practically the same group of officials that control the state administration. Thus, while state positions are amply prepared for, at least in certain of the universities, though German universities, like many American universities, have been all too slow in adding courses in the political, social and economic sciences, adequate to preparation for the highest public positions, these state institutions do not tend to give the specialization and the emphasis upon municipal service demanded by urban needs. This inadequate training of municipal officials and employees, with its accompanying lack of proper specialization and proper adaptation, caused a demand for local institutions that would offer the training necessary and adequate for municipal employees. This is the second factor tending toward the creation of municipal colleges for the preparation for municipal service in Germany.

The burgomeister and the paid expert advisers in the magistrat were, as a rule, well trained at the state institutions. But no special training was provided for the great rank and file of city employees, the efficiency of whom, after all, decides the skill and utility with which the taxpayer's money is spent. The need for training well every municipal employee, so that there will be no lost motion through inadequate preparation for positions, is the third factor leading toward adequate public training for public service in Germany.

The fourth factor lies in the fact that public service is a recognized profession of dignity and permanence in tenure. The oft-repeated assertion that there are no politics in German city positions is far from accurate, for in many cities an avowed member of the social democratic party could never be ratified for a leading city position no matter what his worth, while a conservative of the landed gentry point of view would be ratified no matter how incomplete his preparation. But in Germany the provincialism characteristic of so many American cities, which brands experts from other cities or states as "outsiders" or "allens," finds no place. The result is that a public employee with adequate qualifications, who finds himself blocked in one city because of his party affiliations, can look toward employment in other cities. A position once secured, a tenure for life or for a term of 12 or 24 years, is assured, followed by a pension at the end of service. Moreover, promotion is made from city to city, so that there is no limit to the economic returns

and social prestige of the public official of competence and skill. Even the burgomeister and all the leading expert advisers in the magistrat are chosen at will from other cities. The salary, moreover, is adequate to attract the best talent, and increases in remuneration follow at specific intervals. The national laws frequently provide that appointees to certain positions shall have stated professional qualifications, but all examinations are qualifying and not competitive. The state examinations merely determine eligibility and within the large list of eligibles the magistrat has full discretion in choosing officials.<sup>3</sup> Probationary periods of service, promotion on the recommendation of superior officers, with due regard to merit and experience, security of tenure, protection against arbitrary dismissal, exclusion of civic employees and officials from all participation in election campaigns, all these features of American civil service find a place in the German system. But the arbitrary provisions characteristic of American civil service, such as that the appointing official is limited in his choice to the three highest, finds no place in the German régime. The result is freedom of choice by an employing official who must have the best talent and get the best results within his expenditures, for pressure of the tax is as keenly felt in German cities as in American cities.

The fifth factor making for the inculcation of efficiency principles in the German municipal service is the fact that the great public utilities such as the street railways, gas and rail waterways, are publicly owned and operated. This means that not only the best paying positions, but also the positions carrying with them social prestige and honor, are within the gift of the state rather than in the power of private corporations. The youth of capacity and training turns, therefore, by preference to the public service.

The technical training required for the municipal expert in Germany is usually afforded by some branch of the regular educational system.<sup>4</sup>

In the first place, there are the great technical universities everywhere maintained by the individual states, in which technical training of the most definite and specific kind can be obtained for either public or private expert work. At the present time there are eleven great scientific universities, the organization of which is under the control of the several states of the German empire. The regulation of industries, however, is within the jurisdiction of imperial laws which have established nation-wide standards as to certain technical experts. These laws, for instance, prescribe the qualifications of persons who wish to carry on particular industries, prescribe the powers and duties of the guilds, and require workers to attend continuation schools where such schools exist. The licensing of certain occupations is under imperial control and attendance at some technical schools is practically necessary for those who wish to pass the required state examinations.

Below the highest technical institutions are two grades of machine trade or mechanical engineering schools,<sup>5</sup> those providing for the training of engineers, constructors, foremen, machine draftsmen, etc., and those of a lower grade which train machinists, mechanical draftsmen and technical officials of middle rank and others preparing for positions that require a less highly developed technical ability. To both these classes of schools are often added Sunday and evening courses, open to workmen who cannot afford to give up work entirely and attend school.

But general school training can not make the efficient employee. There are at least two other prerequisites.

\*"Government of European Cities," W. B. Munro, p. 178.

<sup>4</sup>German schools can be divided into the following two classes: (a) State institutions: (1) Those which are supported entirely by the State, and (2) those for which private corporations furnish a share of the cost; and (b) local community institutions, either pure community institutions or those to which either the State or local organizations contribute. There is a third class of institution, supported by associations and unions, which is not carried on for gain, but which requires considerable financial assistance from both the State and the city.

<sup>5</sup>The higher of these requires greater academic preparation and a longer course of study. Into the second will be admitted those without a complete secondary education but who have, at least, one year of practical training. The *Höhere Maschinenschule* is a real secondary technical school, the condition for admission being the completion of the six years' course in the academic secondary school, together with practical work in shop or factory for a period of two to three years.

The first is specific preparation of a kind that could not be expected in a general university, and the second is particular training for those who are employees and officials in municipal service. To meet these two needs a number of strictly municipal institutions have sprung up in Germany. These schools include the special training schools for employees of certain departments, such as the training school for policemen and the college of town planning in Berlin.

A definite movement for local municipal colleges is on foot in Hamburg, Frankfurt-on-Main, Cologne, Dresden and Posen, and the small towns of Altdorf, Willenberg and Helmstedt, all three of which had their own universities in the past and want them renewed.

Cologne has opened an academy whose purpose it is to rescue municipal government from academically trained doctors of law. The curriculum includes definite instruction in social politics, in housing and land questions, in the labor problem, in municipal law, in municipal taxation and finance, in public charity, in care for children, in statistics, in school law.

The work and functions of these new universities can best be expressed by a special study of two of them rather than generalized comment on all of them. For this purpose are chosen the Akademie für kommunale Verwaltung zu Düsseldorf and the Erste Preussische Verwaltungs-Seminar zu Aschersleben.

The purpose of the academy for municipal administration in Düsseldorf, opened for work in the autumn of 1911, is to strengthen and broaden the knowledge of and to offer a scientific and practical training to municipal officials, and to give business-like, scientific and practical education to persons intending to enter the municipal service. A survey of the courses offered and the methods employed indicates that the academy is primarily an institution for the further training of the higher municipal officials.

The courses offered include the following subjects: Rights of taxes; constitutional rights; governmental rights; the police power; social questions; school and sanitary administration and legislation; insurance law; finance; economics; political science; sociology; the resources of the country; national economy; the lawful rights of government; the organization of city, state and nation; efficiency in government; the science of finance; money and banking; municipal utilities; statistics; building regulations and administration; the cultivation of prosperity and of refinement; the labor question; relief of the poor; business law; practical work in administrative law; municipal finance, constitutional law; taxation law, criminal law and procedure; the poor law; the science of work in business; labor union laws and their interpretation; criminology, and book-keeping.

The analytical, practical and thorough character of the courses offered may be gleaned from the content of selected courses. Thus the course in the science of law includes the foundation principles as to the rights of citizens and the rights of officials; purchases, leases, deeds and their characteristics; indemnity obligations of the community; earnings and laws of properties; real estate law, rights of mortgages, the authority of parents and the power of the respective governments as guardians; the rights of associations and of business; commercial law; the foundation principles as to state, rural and city administrative law; the constitution of the state of Prussia, the Imperial constitution, the rights of administrative organs of government, the police power and the general position of the police, including the safety and sanitary police. The course in taxation law includes discussions of the various kinds of taxes, such as professional and occupation taxes; concessions; beer, dog, amusement and other indirect general taxes; double taxation; the increase in taxes and the value thereof; the relation between city, district and provincial taxes. Insurance law includes a history of public insurance, the details as to sick, accident and invalid insurance, the relation of the insured to each other. The course in statistics includes discussions as to the nature of statistics, statistical methods, technique in presenting statistics, the principal province of governmental statistics, etc. Thoroughgoing courses are offered in national economy with special application to the protection of properties and the development of new industrial opportunities. Corrupt practices and efficiency in government are likewise taught, as are the cultivation of prosperity in the different communities and the inculcation of the proper doctrines as to a na-

\* Abstracts from a paper prepared for presentation at the annual meeting of the American Society of Mechanical Engineers.

<sup>1</sup>Wharton School of Finance and Commerce, University of Pennsylvania.

<sup>2</sup>"Vocational Education in Europe," Cooley, p. 11.



tional programme for industrial supremacy. In the course german to pure water for the city are given complete geological data. In short, the courses include minute, reliable, thoroughgoing investigations into the legal, social, economic, political, industrial and even geological ramifications of the municipal official's duties and responsibilities.

Quite in contrast to the Düsseldorf academy, which trains primarily the higher officials, is the Seminary for Public Officials at Aschersleben which offers a one year course preparing primarily for the one year probationary service by the middle and lower classes of public employees, and for promotion from one grade of service to a higher grade of service. The duration of the course is one year. The institution is administered by the magistrat of the city of Aschersleben. The courses offered include jurisprudence, administrative law, the science of taxation, political economy, social administration, the administrative courts, the budget, the treasury, accounting, bookkeeping, stenography, typewriting, arithmetic and German. The student is drilled so that he can hunt up and understand the decisions of the civil and administrative courts. The instructors are employed teachers and the public officials of the city of Aschersleben.

The need for further specialized training in America is to be measured by the extent to which existing educational institutions are meeting the rapidly rising demand for well-trained public officials who can look to permanency in the public service. The rapid adoption of commission government so that to-day it is applied in 306 cities with a population of 7,381,987, the adoption of the city manager plan of city government in 12 cities with a population of 229,662, the rise in the demand for sanitary experts, for engineering experts, for experts in marketing, in pure foods, in accounting, in taxation questions, and in the other fields of expert service in city, state and national life, the increase in the municipal ownership of public utilities, all these mean a rapid increase in the actual number of experts in the public service which in turn must mean greater permanency and better training for the public service.

The universities of our country are already doing a splendid work in providing for the public service. A large number of state scientific bureaus are located at the universities, such as public health laboratories at the Universities of Wisconsin and North Dakota, experiment stations in agronomy and animal husbandry, dairy husbandry, horticulture and botany, such as in the University of Illinois, experiment stations in engineering, such as in the University of Missouri, and testing bureaus, such as those at the University of Cincinnati. In the universities of Wisconsin, Oregon, Texas, Washington, California, Harvard and Cincinnati are legislative reference bureaus, which collect and compile information on matters pertaining to municipal legislation, public works, finance, sanitation, education, bibliographies, and statute-making and interpretation. Through the activities of the Committee on Practical Training appointed by the American Economic and Political Science Associations, our universities are beginning to make an extended use of the agencies for practical training available on every hand, such as the practical work by graduate and well-equipped undergraduate students in tax, railroad and industrial commissions, investigating boards, state boards of public affairs, city departments, boards of health, finance commissions, bureaus of municipal research and the different federal agencies in Washington. These laboratories are being and can be made, to an increasing extent, of as definite value to the students in politics, economics and sociology as the splendidly equipped scientific laboratories in the university buildings. All of the various universities now offer courses in constitutional law, in municipal government and allied subjects. University faculties are being called on extensively for practical work.

The University of Texas, with a large number of small cities round about, though with no large municipal laboratories at hand, such as are available in the largest cities, is planning for a department in municipal administration. New York University has a division of public affairs organized in 1912. The plans for this division include a course for graduate students which will give them an opportunity to conduct original research in problems of municipal government under the direction, not only of the faculty of the division, but also of the faculty of instruction and of permanent members of the administration of the city of New York. Moreover, tentative plans are under way for a system of administrative work for graduate students. This plan involves the assignment of two or more students to the same position, at which they will work in turn. Each will thus have time for college and class work, and at the same time will have an opportunity to get actual experience in public administration. There are, of course, only a limited number of positions in the city departments that can be handled in this way.

The University of Pittsburgh is making a special effort to be of service to the commonwealth and to the community, especially in its School of Economics which provides, through its departments of government and citizenship, an intimate understanding of the rights, duties and responsibilities of citizenship and of the functions and activities of government, municipal, state and federal. Students get special training for public service in commissions and administrative bureaus of various types, and in such semi-public organizations as trade and publicity organizations, bureaus of municipal and social research, and other civic and commercial bodies. In the University of Pennsylvania, students in certain courses, such as the course in municipal government, have been and are being assigned definite practical problems to be worked out through the various public bureaus, departments and public officials in the city. The University of Utah undertakes to disseminate through printed bulletins information that will be of service to the state.<sup>6</sup> The University of Cincinnati is a purely municipal institution which is relating itself in every way possible to the actual problems of the community and of the state. Thus in the department of chemistry of the engineering college is the bureau of city tests which analyzes, examines and estimates the value of all materials submitted by the municipal engineer or the purchasing agent of the city. The department of social science cooperates in social service with public institutions, such as the juvenile court, in investigations, service, etc. The department of psychology has been conducting some interesting work throughout the years past in regard to backward and deficient children in the schools. In this way its work is linked definitely with public school work. The professor in charge of the department of political science is also in charge of the municipal reference bureau at the city hall, which collects information, makes investigations and reports for the city. The college of medicine cooperates with the city hospital, contagious wards, the various clinics, etc. The engineering college cooperates with the city engineering, waterworks, street, sewer and bridge departments, in cooperative teaching, testing, reports and research work. The college of commerce cooperates with the banks of Cincinnati, through their committee, in collecting statistics and reports. In addition to this there is definite service by the individual professors. Students of such an institution necessarily get both the atmosphere and the positive knowledge of great value in their later service for the public. Space forbids the enumeration of other work in other institutions. Our colleges and universities are thus doing much toward practical training for the public service.

### Thinking Animals

About ten years ago it became known that "Clever Hans," an Arab stallion owned by a Herr von Osten in Berlin, was able to answer arithmetical and other questions, tapping out the reply with his fore-foot. Notoriety led to heated controversy, and the appointment of committees to investigate. The second of these, under Prof. Stumpf, resulted in Pfungst's book explaining everything in terms of signals consisting in slight movements made unconsciously by some person present knowing the answer. This seemed to have solved the problem finally until the appearance of Krall's book in 1912. The author, a wealthy jeweler of Elberfeld and friend of von Osten, had after the latter's death continued to experiment, obtaining results which, he claimed, refuted Pfungst's explanation. This claim found support in a report signed by the zoologists, Kraemer, Sarasin, and Ziegler, asserting that signaling was excluded since correct answers were given even when none of the human participants was visible to the animal. The opinions expressed on Krall's book vary from that of Prof. Dexter—"A shameful blot on German literature," to that of Prof. Ostwald, who foresees that it will "as clearly mark the beginning of a new chapter in the doctrine of man's place in nature as Darwin's chief work did in its day."

<sup>6</sup> Some of these bulletins recently issued include discussion of the following subjects: Tests of brick; the construction and maintenance of earth roads; the economical design of reinforced concrete; measurement of flowing streams.

(1) "Das Pferd des Herrn v. Osten (Der kluge Hans)." By O. Pfungst. (Leipzig: J. A. Barth, 1907).

(2) "Denkende Tiere." By K. Krall. (Leipzig: W. Engelmann, 1912).

(3) "Ueber den dermaligen Stand des Krallismus." By Prof. H. Dexter. Reprint from *Lotos*, Prague, vol. lxi., 1914.

(4) "Gibt es denkenden Tiere?" By Dr. S. v. Maday. Pp. x+451. (Leipzig: W. Engelmann, 1914).

(5) "Das Problem der Elberfelder Pferde und die Telepathie." By Prof. H. v. Buttel-Reepen. *Naturwissenschaftliche Wochenschrift*, 1914, No. 13.

(6) "Meine Erfahrungen mit den 'denkenden' Pferden." By Prof. H. v. Buttel-Reepen. *Naturwissenschaftliche Wochenschrift*, 1914, No. 16.

(7) "Eine Kritik der Leistungen der 'Elberfelder denkenden Pferde.'" By Prof. C. Schroder. *Naturwissenschaftliche Wochenschrift*, 1914, Nos. 21, 22.

As to the problem itself, a definite solution could result only from a free and impartial testing of the animals; as it is one can only indicate probabilities. Intentional deceit is almost certainly too simple an explanation, and is in any case inadequate. On the other hand, the probability of obtaining correct answers by chance has been underestimated in view of the number of unsuccessful attempts and the greater frequency with which certain numbers occur. Very much must be allowed for this and other weaknesses of testimony, the demonstration of which has been one of the successes of applied psychology, but which, as every newspaper now shows, are seldom given weight in practice. They particularly affect some at least of the would-be crucial tests. Nevertheless much remains, of which the following main explanations have been offered.

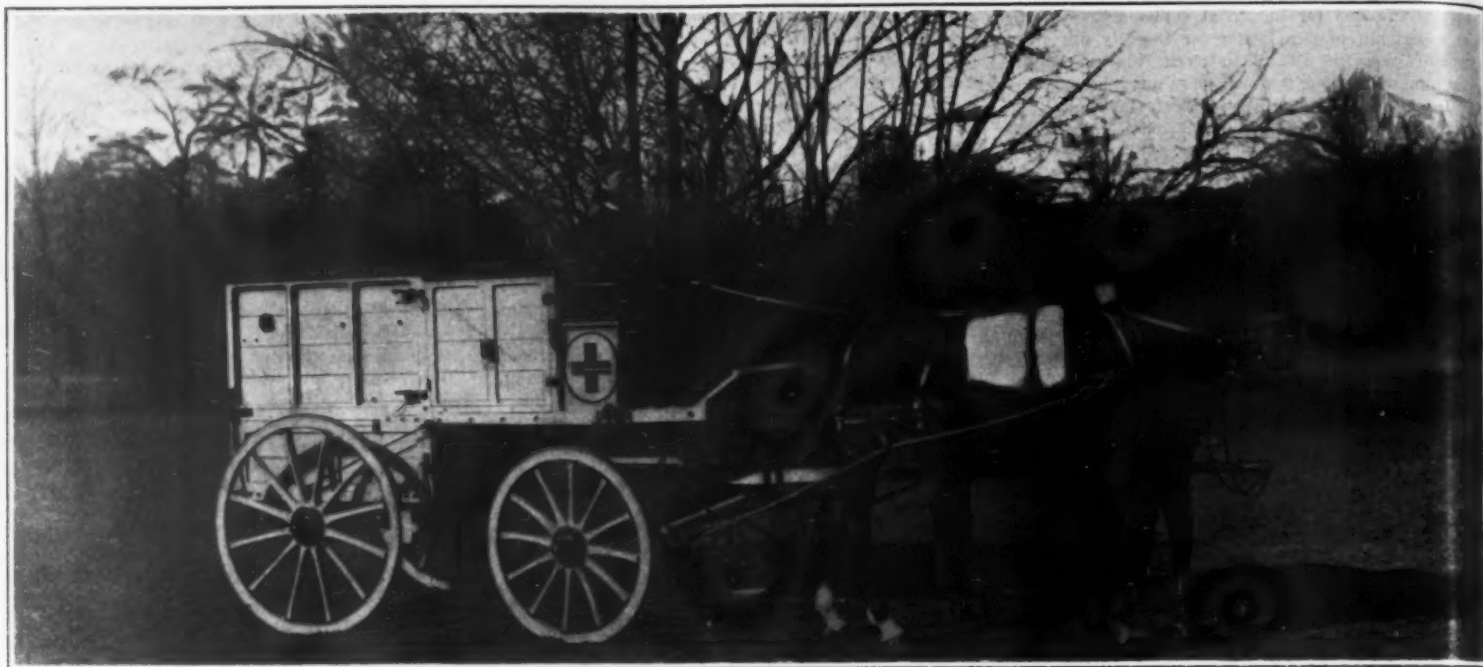
The answers are evidence of mathematical intelligence. This, although a highly developed "number-sense" has been found in persons of low general ability, and even in the feeble-minded, conflicts with all that we know from other sources about the animal mind. Detailed scrutiny of Krall's account of his teaching shows that the problem often could not have been understood from his exposition. Again, the correcting of a single false figure is done quickly and certainly, as might be expected if signals were being given, since these would be facilitated by concentration of the signaler's attention; if the errors are mistakes of calculation it is odd. Finally, the inability of the animals to prove their understanding by action, compared with their eloquence in the language of taps, is extremely suspicious.

The answers are due to memory. The horse's memory is, no doubt, excellent for some things, and the theory has advantages, but also serious difficulties. To associate eight taps with one symbol and nine with another, the horse must be able to distinguish the two series. But it seems probable that animals cannot distinguish numbers beyond four or five. Rothe trained his dog to come only at the fifth whistle—but this only if the whistles were at regular intervals: his horse would take four lumps of sugar in preference to three, but confused four and five. Again, the horse's eye, while very sensitive to movement, is probably unsuited to the clear perception of complex visual forms such as written numbers, and, as a matter of fact, the animals seem to attend to the questioner more than to the blackboard. Finally, the mistakes in cube root, etc., questions strongly suggest the use of tips.

The animals are responding to unconscious signals. Krall claims to have refuted this by "ignorant" experiments, but these are relatively few and seem to have some weak spot. Thus Mackenzie reports that Rolf, the Mannheim dog, described a picture on a card held so that the holder could not see it; unfortunately, the picture was a red and blue cross, and there is reason to think that dogs are nearly color-blind. Nevertheless, the fair number of "peep-hole" experiments and the case of the blind horse, Berto, seem to stamp as inadequate Pfungst's theory of visually perceived movements. Yet no other mode of signal seems sufficient for all cases, while Hacker did actually get answers by moving his foot. Again, it is unlikely that the many individuals who have obtained answers should all make precisely the same unconscious movements. These difficulties disappear if we suppose the animals not to be blindly reacting to one specific stimulus, but to be interpreting more or less intelligently a general type of unconscious emotional ideomotor expression—movement, variation of respiration, etc.—possibly always complex and varying with the individual and occasion. Both horses and dogs are notoriously sensitive to shades of emotional expression, and recent work by the Pawlov school indicates that dogs can hear sounds so faint as the beating of the heart. It is true, any theory of unconscious signaling presents difficulties. Units, tens, etc. are tapped with different feet; the spelling of verbal answers is phonetic, and spontaneous utterances are recorded, including a letter dictated by Rolf! Can the subconscious be credited with so much? The solution, if it ever comes, can scarcely fail to illuminate, if not the animal mind, at least that of man.—From *Nature*.

### A Military Wireless Outfit

WIRELESS communication is destined to play an important part in warfare, and undoubtedly is doing so to-day, although comparatively little is heard of it so far. In this country the Signal Corps of the Army has recently acquired an unusually complete portable wireless outfit, which is believed to be the most powerful of its kind. The apparatus is mounted on a motorcar chassis and can be set up complete and in operating condition in as short a time as twelve minutes. Under favorable conditions, the apparatus has a sending radius of up to 800 miles. Messages from points 2,500 miles distant have been received. The generator which furnishes the current is driven by the same motor that propels the vehicle. Antenna of the umbrella type are used, the mast, which is in blue sections, being 85 feet in height.



A German field outfit for X-ray treatment.

## X-Ray Work in War

Developments in Practical Applications as Now Used in the Field and in Hospitals

By the Berlin Correspondent of the Scientific American

THOUGH X-ray work has, even in normal times, become so valuable an aid to the medical practitioner that no up-to-date hospital can do without it, it is even more useful and necessary in warfare. Whenever, for instance, the shape and position of a projectile in the body of a patient are to be ascertained, Roentgen photography will quickly give all the desired information; if injured bones, and especially the splintering so frequent with bone fractures (shot fractures), are to be examined, it again proves the one safe guide. Roentgen photographs are nearly always welcome if the perforation made by a bullet has such a direction as to suggest the hypothesis of a bone lesion. The photographic plate in many cases shows the lesion to be much more serious than would otherwise have been supposed. In connection with the further checking of the treatment—in ascertaining, e. g., whether displacements of the bone ends have been adjusted by the dressing, repeated X-ray examination is of the highest importance.

It is true that X-ray work in its primitive form would have been of little use on the theater of war; but so many improvements have been introduced of late years, the technicalities have been so highly simplified, that even the ordinary practitioner will find no difficulty now in handling an X-ray outfit. Transportable apparatus allows the Roentgen ray to be readily employed everywhere in the field, even in temporary infirmaries. A particularly valuable feature is that patients submitted to a Roentgen treatment will suffer no pain or discomfort.

The apparatus serving to generate the rays may be of the most different types. They either consist mainly of an induction coil and interrupter—the active rays being produced by a rapid succession of alternate current impulses—or of a rectifier converting an alternate current into pulsating direct current, that is, a rapid succession of high-tension current impulses of constant direction. The latter type of apparatus is not only more simple to operate, which is especially valuable in warfare, but generally more effective, allowing snapshots to be taken in fractions of a second.

In the military hospital founded by Messrs. Siemens and Halske, in conjunction with the Siemens-Schuckert Works, the German Red Cross and the military authorities, there has, for instance, been installed an X-ray outfit allowing instantaneous views with exposures of only 1/100 second to be taken. This hospital, moreover, shows many other striking features, and may be considered representative of the best German practice in military surgery. It is housed in the administration building at Siemensstadt, near Berlin, and comprises in the four stories of its northern wing, four hundred beds in seven large halls and eighteen private rooms. An operation room appointed in accordance with the best modern practice enables even the most extensive surgical operations to be performed, mainly with the aid of X-ray pictures previously taken. By the courtesy of the managers, we are able to reproduce some such views derived from the hospital archives, which will be found most instructive. In another hall there have been installed all sorts of apparatus for electro-medical therapy.

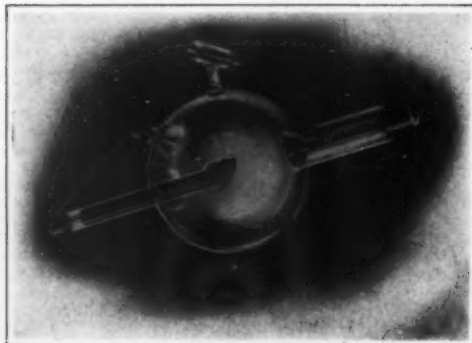
Special transportable Roentgen outfits have been perfected for army hospitals installed at halting places, which generally remain stationary for some time. Beside the X-ray generator, these comprise a current generator, mostly a gasoline dynamo, so as to be independent of any electric installation. While these outfits do not lend themselves to taking instantaneous views, they allow even difficult X-ray pictures to be made with a few seconds exposure in conjunction with a reinforcing screen. The various parts of this outfit are contained in cases carried on automobile trucks, which, as long as the hospital remains at a given place, can be utilized for the transport of wounded soldiers. Special type of X-ray outfits have been developed for ship hospitals and hospital ships.

So large a number of pieces of electro-medical apparatus have been lately adopted that they cannot possibly be left out of account in a discussion of X-ray apparatus, the more so as they are directly or indirectly the outcome of the latter, and serve as efficient auxiliaries in Roentgen practice. Foremost among these should be mentioned the diathermic apparatus which by the application of high-frequency currents produces some sort of internal heating of the body. Diathermics is used with advantage in the treatment of neuralgic, rheumatic and gouty complaints; it is most valuable in the after-treatment of bone lesions, and its anesthetic effects are remarkable.

Electric temperature measurements are used in a rather unusual way at the Siemensstadt military hospital. The same as temperatures are determined and checked electrically from a central station in large heating and ventilating plants, the fever temperatures of



X-ray of a wound in foot caused by rifle bullet.



Siemens tungsten X-ray bulb.



Triple fracture produced by a rifle shot.





Recording fever temperature of a patient during a test of the effect of a sudatory.

patients are here recorded electrically and signaled to a central post. This, of course, affords a great advantage over the usual method of determining the temperature of the patients two or three times a day; in fact, the clear record of the course of temperatures thus obtained not only assists more efficiently in making a diagnosis, but affords some useful data in gauging the effect of medicaments or therapeutical methods.

Apart from the Roentgen apparatus proper, we should mention the accessories without which no sharp views could be taken. The same as in ordinary photography, a stop is placed in front of the objective, to keep off any lateral beams of light and thus to improve the definition of the picture, it is a good plan in X-ray work to screen off any secondary rays which are bound to impair the quality of the picture. The "compression" stop devised by Prof. Albers-Schönberg allows any part of the human skeleton to be reproduced with the utmost accuracy. Another type is Dr. Bucky's "beehive" stop, which intercepts any secondary rays produced inside the body before these are allowed to strike the projection screen or photographic plate.

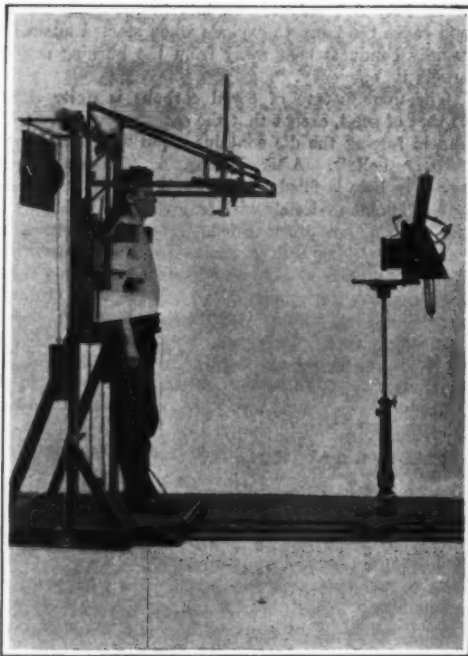
For radioscopic and radiophotographic work on standing, sitting, or lying patients there have been devised quite a number of folding stands which will keep the body straight, in addition to avoiding displacements and insuring an accurate adjustment of the body.

The X-ray bulb itself, of course, is of the highest importance. Each military hospital ought to be equipped with quite a number of bulbs adapted for various purposes, part for radioscopy and part for X-ray photography. According to the special purpose each bulb is intended to serve, the vacuum must be more or less perfect; the higher the vacuum, the "harder" or more penetrating will the X-rays be, and *vice versa*.

A minor, though useful, accessory are the sand bags, which allow the patient to be installed most comfortably in any position.

The ascertaining of foreign bodies (projectiles) in the patient's body is generally limited to the upper extremities, neck, thorax, and to the lower extremities from the knees downward, as well as the skull. In order to mark certain points for subsequent treatment, small

lead labels are glued to the skin, or the places in question are spotted with a blue pencil, ink, or tincture of iodine. In order accurately to ascertain the positions of a projectile in the body, two views—in planes vertical to one another—are, of course, required. A safe diagnosis for bone fracture can hardly be made on the strength of radioscopy, X-ray photography being gen-



Schmidt's universal X-ray stand.

erally indispensable in this connection. For checking the fracture in the plaster dressing, as well as for the diagnosis of sprains, radioscopy, on the other hand, mostly affords sufficient data to allow a safe conclusion to be arrived at.

Another point to be mentioned is that parts generally invisible (e. g., in examining the stomach and intestines) can be made visible by administering to the patient what is called a "contrast" meal, comprising some heavy metal salts, such as bismuth, impervious to X-rays.

#### Wireless Telegraphy\*

DURING the early part of March Mr. Marconi joined one of the Italian war vessels at Augusta attached to the squadron commanded by H.R.H. the Duke of the Abruzzi, and for several days he carried on experiments in wireless telephony with most satisfying results. During the first day radio-telegraphic communications were received from Rome over a distance of 366 miles,

\*The Engineer.

from Vienna over a distance of 600 miles, and from Clifden, in Ireland, 1,750 miles away. These communications were made during the day, and new high resonance receivers with photographic register repeaters were employed with excellent results. Experiments in wireless telephony were carried out on the following day between several vessels lying at anchor at a distance of one kilometer with great success. The wireless telephone experiments were continued on the third day, this time between two warships on the high seas, and the reception was consistently perfect over a distance of 30 kilometers. On the fourth and last days successful telephone experiments were again carried out, communications taking place with very limited energy between vessels on the high seas, 70 kilometers (45 miles) apart. On the last day radio-telephonic communication was constantly maintained for 12 hours, and the continuous working of the apparatus did not cause the slightest inconvenience. The apparatus employed in the experiments is of a new and simple type, and it was Mr. Marconi's desire that it should first be used on the warships of the Italian Royal Navy.

A new transmitting apparatus for wireless telephony was invented by Herr L. Kuhn. The microphone current is passed through a winding on a soft iron core on which is wound a second coil connected with the antenna circuit. The self-induction of the latter coil varies according to the fluctuations in the microphone circuit, and the oscillations in the antenna circuit, therefore, also vary in frequency accordingly. By this means it is stated that an oscillation energy of 8 kilowatts in the antenna circuit has been sufficiently influenced by a microphone energy of only 8.7 watts to effect a proper transmission of speech.

#### Effect of the War Upon Crime

THE *Basle Nachrichten* publishes a summary of the offenses against the Swiss penal code, just before and since the outbreak of the war, concerning which complaints were made to the police authorities. While during July of the present year 269 complaints were made, the number reported for August is only 152, for September 177, and for October 158.

The statistics for 1913 give the following totals: July, 343 complaints; August, 314; September, 208; October, 301. At the close of July, 1914, the number of cases tried by the public prosecutor was about 140 more than for the same period of the previous year, while an inspection of the statistics up to the end of October shows a decrease, there being about 130 trials less than for the year 1913; that is, there was a falling off of about 270 cases in three months.

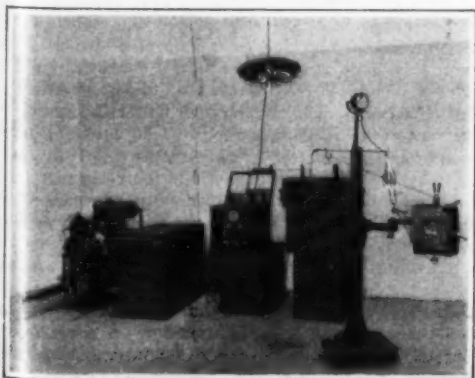
The German journal *Umschau*, in discussing these figures which it quotes, says that one important reason for this striking decline in the perpetration of crimes is that the floating population, from which a large percentage of the lawbreakers is drawn, has been largely reduced since the beginning of the war by removals, summons to the armies, expulsions, etc. The mobilization of the Swiss army has also exercised a favorable influence upon criminal statistics.

The fixing of an hour for the closing of the saloons led to an abatement in assaults, crimes against property, threats, and acts of insubordination. Most interesting of all are the figures concerning the complaints of assaults.

In 1914 the complaints as to premeditated bodily assaults run as follows: July, 28; August, 13; September, 18; October, 17. In 1913 the figures were: July, 37; August, 31; September, 29; October, 25.

In the months of August, September, and October, 1913, there were 9 complaints in regard to acts of insubordination, while during the same period of the year 1914 only a single case was brought before the division for criminal investigation.

In a few cases of brawls the quarrels arose from the fact that the sympathies of the population of Switzerland are divided between the countries at war.



Portable military X-ray outfit.



An automobile fitted with an X-ray outfit.

# Chemistry of Flaming Arc Carbons\*

## Their Development and Operation

By Dr. William C. Moore

In an arc struck between two carbon electrodes, very nearly all the light comes from the incandescent electrode tips. In a direct-current arc, the positive crater is larger, and possibly at a higher temperature than the negative crater, and it is this positive crater which is the source of most of the light. Since the crater is merely an incandescent solid, it affords a continuous spectrum. Colorimetric experiments recently made by L. A. Jones and reported by him at the Cleveland meeting of the Illuminating Engineering Society, September, 1914, show that this incandescent crater has about 67 per cent of the daylight value of noonday sunlight. When volt-ampere readings are taken with such an arc it is found that if the arc is strengthened the voltage rises and the amperage falls, and eventually the arc goes out.

If we use as one of our electrodes a carbon rod which has been hollowed out into a cup, and place in the cup some potassium chloride, and again strike the arc, we find that the volt-ampere characteristics are changed and that at the same amperage a much longer arc can be drawn. Cassellmann in 1844<sup>1</sup> seems to have been the first to have noticed this fact. As we see, an arc fed with potassium chloride gives very little light; in fact, probably less than the pure carbon arc, as the positive crater is not so bright. This arc has a distinctive color, and, of course, would show, besides the carbon arc lines, the potassium lines in the spectroscopy. Bunsen<sup>2</sup> in 1844 seems to have been the first to notice that different materials give different spectra in the arc.

If, instead of potassium chloride, we place a small amount of calcium fluoride in the hollow carbon cup, which, in this as in the previous case, is in the lower positive carbon, we find that the arc length for a given current and voltage is much shorter than for potassium chloride, and longer than for a pure carbon arc; moreover, the arc is intensely luminous, though rather unsteady and liable to go out. On placing a mixture of potassium chloride and calcium fluoride in the arc, we get the combined advantages of a long arc, with more intense luminosity than is afforded by either the pure carbon arc or the potassium chloride arc alone. These simple facts form the starting point in the development of the modern flaming arc.

About 1899, Bremer, in Germany, brought out a flaming carbon, with calcium fluoride as the essential light-giving salt. The light afforded by such a carbon is a sensation yellow; the color is more aptly described, however, as "minus blue," as the spectrum of such an arc is very deficient in the blue.

From 1899 to the present the development of the flaming arc has been going on steadily and surely. It is interesting to note that the first record the National Carbon Company has of any work being done by them on the subject was when some ordinary cored carbons flamed and experiments were undertaken to prevent this phenomenon.

Although Bremer produced a carbon which could be burned vertically, for a number of years most of the commercial lamps were "inclined trim" lamps, taking long, cored carbons, which burned under open-arc conditions. A few years ago, however, there was developed a lamp for burning flame carbons in a vertical position, and for these lamps solid carbons have been developed. An interesting point is that the idea of solid carbons antedated the development of the lamps. These lamps generally operate in such a way that a limited supply of air reaches the arc; that is, under "inclosed-arc" conditions. These various types of lamps are doubtless familiar to the illuminating engineers present.

Modern flame carbons may be classified in several ways. From the standpoint of the mechanical structure of the finished carbon, we have cored carbons and solid carbons. From the standpoint of the color of the light emitted by the carbons, we have a major division in which are included yellow flame carbons and white flame carbons, and a minor division including red, green and blue flame carbons, red and green being but little used except for advertising purposes, and blue being used as a source of blue and ultra-violet light for medicinal purposes.

In the major division, calcium fluoride is the chief constituent of yellow flammers, and rare earth compounds the chief constituents of white flammers.

A brief description of the method of manufacture of flame carbons may not be out of place. The first step, of course, is the careful weighing out of the requisite amount of the carbon base, and the proper flame materials for making a "mix." Most of these mixes are rather complex. After weighing, the ingredients are very thoroughly incorporated together and with an appropriate binder—generally tar or pitch or a mixture of these. The "mix" is then forced by means of an hydraulic press into long rods, which after cooling are cut into the proper lengths. These green carbons are then carefully baked in gas-fired furnaces and the temperature gradually raised according to a definite schedule, the final temperature attained being determined by a number of factors, such as the liability of some of the constituents to volatilize, or to react with each other and the carbon.

After cooling in the furnace, the carbons are unpacked, sorted, cleaned and gaged, the latter process consisting in determining the diameter, as but small variations in diameter are permissible; the carbons must also be quite straight. Some solid carbons are electroplated with copper on the holder end to make a better contact between the lamp holder and the carbon. After plating, they are dried and made ready for shipment.

It is, of course, necessary to keep all flame carbons dry, as water may cause reactions between some of the flame materials, or may set up on a carbon-copper cell with some of the soluble or partially soluble salts as electrolytes and thereby destroy the copper coating. Water has another detrimental effect as shown by W. R. Mott,<sup>3</sup> namely to react with the carbon at high temperatures, forming carbon monoxide and hydrogen; the latter may not only accumulate in the lamp housing and cause the lamp to explode when started again, but rapidly conducts heat away from the burning arc and lowers its efficiency.

The manufacture of cored carbons is quite similar to that of solid, except that the carbon base is different, and in forcing the die contains a pin which makes the carbons hollow. After baking, sorting and gaging this core hole is filled with a mixture of a carbon base and the flame materials with an appropriate binder, and the carbons are then dried. As cored carbons are usually very long and of small diameter, a zinc wire is inserted into a small hole parallel to the core hole. This wire increases the conductivity of the carbon. In order to make a good contact with the carbon and the holder, the carbons are "silver tipped"—that is, first copper plated, then dipped into solder, which solders the zinc protruding from the holder end to the carbon. Such a connection is a permanent one, and is far superior to the scheme of simply bending the zinc over at the end of the carbon as the zinc becomes brittle when the core is dried and is liable to break off.

We now come to the question of desirable operating characteristics for a flame arc carbon. First of all, such a carbon should be reliable. It has been pointed out by Steinmetz<sup>4</sup> that after high efficiency is attained, we can afford to sacrifice some of the efficiency for reliability and other desirable factors. As will be shown below, the flame arc is already of high efficiency, hence we place reliability as our first desirable characteristic.

We may consider reliability under the four heads:

1. Constancy of distribution.
2. Constancy of light flux.
3. Constancy of color.
4. Ability to start with cold points after the carbons have been in use.

The length of the arc has a great deal to do with the amount and distribution of light. As the arc lengthens, the voltage increases; it is stated by Hechler<sup>5</sup> that there is a maximum definite voltage for maximum efficiency, that is, some definite arc length gives the most light.

The part that chemistry has had in increasing the reliability may be briefly indicated. It is readily seen that a flame arc which burns brightly part of the time and dimly part of the time can hardly be said to have 100 per cent reliability if all the other factors are high. It may happen that all the flame material is evaporated from a given spot on the surface of the carbon, thereby causing a pure carbon arc for a short time. Such changes, however, are now rare, as a great deal of constructive chemical work has practically obviated

this feature. As another factor affecting the reliability of operation of flame arc lamps is the formation of slag on the points or on the lamp mechanism, it is readily seen that the proper proportion of the flame constituents and the right kind of addition agents for preventing such slags are of great importance, and here again we find that extended chemical research has resulted in the development of carbons in which this source of trouble has been largely overcome.

It has been mentioned that the flame arc is of high efficiency. The following figures are from some regular routine tests made in the laboratory:

Lamp	Current	Kind of Carbon	M.S. C.P.	Arc Watts	Watts per Candle
Excello.....	A.C.	Cored—yellow.....	1,230	363	.29—
Excello.....	A.C.	Cored—white.....	843	369	.43—
Excello.....	D.C.	Cored—yellow.....	1,462	445	.30—
Excello.....	D.C.	Cored—white.....	875	450	.51—
G. E. Type W.....	A.C.	Solid—yellow.....	700	397	.59—
G. E. Type W.....	A.C.	Solid—white.....	808	394	.49—
G. E. Lynn.....	D.C.	Solid—yellow.....	1,181	409	.35—
G. E. Lynn.....	D.C.	Solid—white.....	939	421	.45—

The slightly lower efficiencies with the solid carbons are due to the fact that they are used in inclosed lamps, to which the air has only limited access, and so in these lamps there is less oxidation of the carbon and the flame material.

Some work by Henry P. Gage<sup>6</sup> at Cornell University on the efficiency of the arc stream proper may be cited here. This investigator found that with cored yellow-flame carbons the energy radiated as light from the arc stream was 39 per cent of the total energy radiated by it; with the arc stream, from cored white flame carbons 27.5 per cent of the energy radiated by the arc stream was light energy. The entire yellow arc showed six candles per watt radiated, while the entire white arc showed three candles per watt actually radiated.

These values are for the spectral region between 3,800 and 6,800 Angstrom units, and for alternating current at 13.5 amperes. The following data may be presented as to the life of flame carbons:

	Life in Hours.	
	A. C.	D. C.
Cored, yellow.....	12.0	12.50
Cored, white.....	11.08	11.25
Solid, yellow.....	115.08	125.0
Solid, white.....	120.0	96.42

These figures show why the inclosed flame arc lamp is more popular than the old "inclined trim" lamp, using cored carbons.

Having indicated at a number of points the important part chemistry has played in the development of the modern flame carbon, let us now take up in greater detail some of the chemical aspects.

In the first place, the selection of the proper materials for the manufacture of flame carbons is to a very large degree dependent on the chemical properties of these materials. When we consider the carbon base, we find that the chemical behavior, as well as the physical behavior of the various so-called forms of carbon, differs with the type of carbon employed. To use an extreme case as an illustration, we know that the chemical properties of graphite differ greatly from those of lampblack. There are likewise similar differences between charcoal and lampblack, petroleum coke and retort coke. This, in part, accounts for a different carbon base being used for solid and for cored carbons.

To a greater degree than the proper selection of the right carbon base the selection of the right sort of flame material and the right sort of addition agents with this flame material has been a chemical problem. This is illustrated by the fact that to-day we know no better material than calcium fluoride for the main constituent of yellow flame carbons. I do not think I will exaggerate the matter in the least when I say that compounds of every compound-forming element have been proposed as proper substances to incorporate into flame carbons—some of them in all sorts of possible and impossible combinations.

Having selected the right materials, the right amount of each is our next chemical problem. That the candle power depends upon the amount of flame material is well known; more exact information on this subject, however, may be had from the following table, which is from some work done in our research laboratory by

\* Paper read before a joint meeting of the New York Section of the Electro-chemical Society; the American Illuminating Engineering Society and the American Gas Institute.

<sup>1</sup> Pogg. Ann. 63, 576 (1844).

<sup>2</sup> Borsellius, Jahresbericht über die Fortschritte der Chemie und Mineral., 25, 30 (1845).

<sup>3</sup> Mott, Electrical World, December 13th, 1913, p. 1,230.

<sup>4</sup> Gen. Electric Review 17, 180 (1914).

<sup>5</sup> Abstract in Electrician (London), 69, 658 (1913).

<sup>6</sup> Phys. Rev. 33, 111 (1911).



Mr. William R. Mott, using cored carbons in an Ex-cello direct current lamp:

Parts of calcium fluoride by weight.	3	2	1	0
Parts of other salt by weight.....	0	1	2	3

Mean spherical candle-power..... 927 1,058 765 574

As is seen, there is a maximum per cent of each of the constituents which will give the most light. This is true with nearly every substance which may be added to the calcium fluoride, and when we consider that flammors contain three or more substances in addition to the main constituent, it is readily seen that the nice adjustment of all these substances to each other presents some very interesting problems. It also explains why so much of our knowledge has been obtained in an empirical way. It is, of course, understood that the maxima for different addition agents do not coincide.

The chemical control of the impurities present in the raw materials is of great importance. Silica, ferric oxide and alumina, as is well known, are common impurities in calcium fluoride, and it so happens that too much of these impurities will make a poor burning carbon. Silica is especially undesirable, as calcium silicate is very non-volatile and so is a frequent cause of slag formation. The analytical difficulties in determinations of fluorine, silica and rare earths in the presence of each other and of carbon are very great.

The unbaked carbon is a poor conductor of electricity. It is also rather friable. In the baking, the binder is coked and the carbon is rendered homogeneous and conducting. This coking of the binder is the chief chemical change in the manufacture of the carbon.

We now have to consider what chemical changes may

occur during the burning of a flame carbon, and how these may affect the light emitted from the flaming arc. There are three possible sources of light in the flaming arc: electro-luminescence, thermo-luminescence, and chemiluminescence. We do not know to what extent these three factors affect the light radiation in any one case. We do know, however, that in general there are two types of flaming arcs, (1) those in which the outer sheath seems to be intensely luminous, (2) those in which the core of the arc seems to be more luminous than the sheath. With very few exceptions arcs of the latter type give light of the shorter wave lengths. We have here an arc into which calcium fluoride is introduced, it is a representative of the first type; here is an arc into which chromic oxide is introduced, it is of the latter type. King has recently reported<sup>7</sup> that in a tube furnace almost all of the spectral lines seen in the arc spectrum of titanium appear, so that it would appear that in some cases a large proportion of the light from an arc is due to thermo-luminescence, though all possibility of chemical change was not precluded by these experiments.

Oldenberg<sup>8</sup> has made a spectro-heliographic study of various arcs, with some interesting results. For instance, he concludes that in the sodium arc, lines belonging to the principal series such as the "D lines" are due to chemical reactions between the vapor and the air. Band spectra seem to be of two types: those of the first type are due to collisions of atoms in the high temperature core of the arc. The cyanogen bands always seen

<sup>7</sup> *Astrophysical Journal*, 39, 139 (1914).

<sup>8</sup> *Zett. f. Wiss. Photog., Photophysik und Photo. Chem.*, 43, 133 (1913).

in a carbon arc he ascribes to collisions between carbon and nitrogen atoms. Bands of the second type are found in the sheath of the arc; they are due to undecomposed molecules; the bands of the calcium fluoride spectrum are of this type. When we consider that the flaming arc is a miniature electric furnace; that Frey<sup>9</sup> showed years ago that oxygen converts calcium fluoride into calcium oxide; that calcium oxide and carbon react to give calcium carbide and carbon monoxide, and that the other constituents of a flame carbon may react with calcium fluoride, with the carbon, with each other and the atmospheric gases, we see that it is possible for chemical changes to play an important part in the production of the light of the calcium fluoride arc. Each of the possible substances may play its part in this light emission.

In conclusion, I think we may safely say that the past progress made in the flaming arc art has been due to the co-operation of the chemist, the physicist, and the electrical engineer; the future progress will likewise be dependent upon their combined efforts.

It might not be out of place to point out that the behavior of any one substance in the arc is determined by the conditions surrounding that substance—it behaves according to definite chemical and physical laws; and that our knowledge of these laws for high temperatures is exceedingly meager. On the other hand, once these laws are learned, it will probably be easier to build lamps to suit the carbons rather than to make a carbon to fit any and every lamp. In the extension of our knowledge of these laws, chemistry and especially physical chemistry will play an important part.

<sup>9</sup> *Ann. Chem. Phys.*, (3) 47, 17 (1856).

## Uniformity in Dosage of Radium Emanation\*

### The Various Forms Employed and Methods of Preparation

By William Jay Schieffelin, Ph.D.

RADIUM emanation is assuming importance as a therapeutic agent. The Council on Pharmacy of the American Medical Association has listed radium and its emanation among new and non-official remedies; an increasing number of physicians are using the emanation in their practice, and articles and advertisements on the subject are appearing in the medical journals. Since radium and its emanation are becoming recognized as belonging in the materia medica, their production and properties and the standardization of their preparations may be claimed to come within the scope of pharmacy.

Radium is prepared from carnotite (vanadate of uranium and potassium), uraninite or pitch-blende (uranium oxide), and samarskite (columnate and tantalate of uranium and yttrium). Radium has an atomic weight of 226, and resembles barium in its chemical properties.

In its characteristic property of radioactivity radium is sublimely superior to its environment, whether in its natural minerals or isolated from them, and in all of its chemical compounds it is constantly emitting alpha rays and emanation at a uniform rate, and there is no known way of influencing or halting this activity, which is not affected by the extremes of heat and cold, by pressure or the strongest reagents. This radioactivity shows the energy which results from the disintegration or transmutation of radium into elements of lower atomic weights.

A milligramme of radium expels 136 million separate alpha particles per second, which are made visible in a spharoscope. The alpha rays emitted from one three thousand millionth of a grain of radium can be detected by the gold-leaf electroscope. The rays are given out uniformly in all directions in the form of continuous volleys of tiny projectiles travelling at a rate of 12,000 miles per second. Their range is nearly three inches in air and many yards in a vacuum. They are not penetrating, being absorbed by thin sheets of aluminium, paper or glass. Only a small fraction of the alpha particles is set free, unless the radium salt is spread out so as to present the largest possible surface.

The emanation is a gas, which, in turn, steadily disintegrates into alpha particles and radium A, from which in the same way come radium B, C, D, E, and F in succession. It is from these products, especially radium C, that the beta and gamma rays are given off. The beta rays are electrons of negative electricity, the same as the cathode rays, except that the velocity of the beta particles is much greater, approaching the velocity of light, 186,000 miles a second.

The gamma rays are not considered to be particles of matter, but are waves in the ether similar to the

X-rays. They are far more penetrating than the alpha and beta rays, and used in the external application of radium in cancer, the others being easily excluded by thin metal filters.

The emanation has an atomic weight of 222, and a characteristic bright line spectrum. It belongs in the group of inert monatomic gases with helium and argon. It is not absorbed by any known re-agent and shows no power of chemical combination. The emanation is 100,000 times as active, weight for weight, as radium. Like other gases, it can be collected, confined and handled in ordinary glass containers. This is usually done only when it is mixed with enormously greater volumes of air or other gases. Like other gases, the radium emanation is somewhat soluble in water. It disintegrates at the rate of one-half in about four days, and since the radioactive products into which the emanation disintegrates decay at the rate of one half in a few minutes, it follows that the total radiation from the emanation and the subsequent disintegration products decreases at the same rate as the emanation, namely one half in about four days.

When water with emanation in solution is left in an open bottle the emanation diffuses out, and if the water is shaken up or otherwise disturbed the process of diffusion of the emanation is accelerated. From 10 to 30 per cent of the emanation in solution in water may be lost by pouring from one vessel to another.

The strength of radioactive water is usually expressed in mache units per liter. Radioactive water of 2,700 mache units contains per liter as much emanation as is emitted in thirty days by one microgramme of radium (1 mache unit equals 0.001 electrostatic units, one of which equals 3.33 by 10<sup>-9</sup> amperes). The radioactivity of water is measured by a fontactoscope, which is an electroscope with a chamber for ionized air and a scale for measuring and timing the discharge. The instrument is standardized by first testing a solution of a known amount of radium chloride which has been sealed thirty days. Great care must be used in sampling the water.

Water is charged either by dissolving the soluble bromide or chloride of radium or by submerging the insoluble sulphate. The latter is more economical, but the sulphate must be in a minute state of sub-division and must present the largest possible surface.

There are several ways of accomplishing this:

First—Precipitating the sulphate on asbestos and placing it in a porous cell.

Second—Mixing it with charcoal and forming into slabs.

Third—Mixing it with cement and forming balls.

Fourth—Mixing it with clay and firing it, forming terra cotta.

Most of these processes are protected by patents. The

advantage of using an insoluble salt is that it can be employed repeatedly and its use continued indefinitely. The terra cotta rods can be used eighteen hundred years and still have half their radium content available.

Moreover, they avoid introducing into the organism a permanent radio-active body, as is done if a soluble salt is administered.

While a given amount of radium always emits a constant and uniform amount of emanation, the proportion given out by an insoluble salt depends upon its state of subdivision.

In the insoluble salts most of the emanation is occluded by the salt itself; in compact form the sulphate will only yield two and a half per cent, while if it is finely powdered and divided so that it presents a large surface, ten per cent can be obtained.

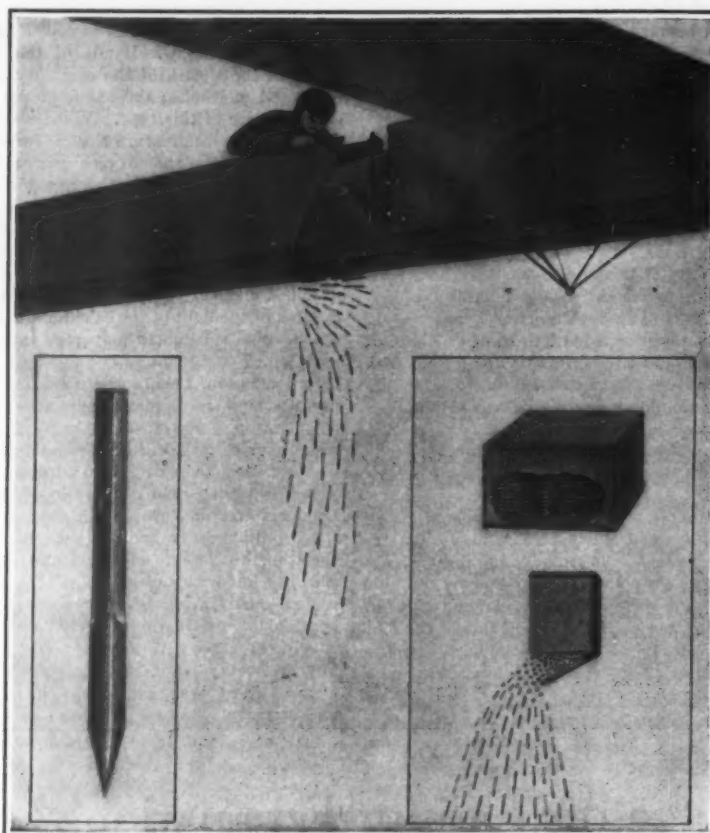
A uniform strength of emanation is obtained when the same amount of radium sulphate is held in the same state of subdivision, submerged in the same volume of water for the same length of time.

If it is desired to prepare doses of 100 mache units, and the sulphate can be held in such a state that ten per cent of its emanation is available (as is the case when distributed through porous terra cotta) it will be convenient to use an amount of radium which would yield 2,000 mache units and submerge for four days in tightly closed containers, when one half of ten per cent or 100 mache units will be obtained.

The stronger natural springs contain from one to two hundred mache units per liter, with which they are charged while flowing over radioactive minerals or passing through cavities where the emanation has collected. The reason why many mineral waters when drunk at the springs give therapeutic results unattainable when they are bottled and transported, is the speedy dissipation of the fugitive emanation, which is reduced to one half in four days unless there is a source for its renewal. The means of renewing the radioactivity of bottled waters, or of charging any water with emanation, are afforded by the above-mentioned devices, and the physician may prescribe a drinking cure which can be carried out with precision in the patient's home.

The chief effect of the radiations from radium and its disintegration products is to produce an ionization of the atoms of whatever substance the rays penetrate. Chemical effects follow as a secondary result of the ionization. Von Noorden and Falta say that "In contradistinction to all other forms of electro-therapy, we possess in the radioactive substances a means of carrying electrical energy into the depths of the body, and there subjecting the juices, protoplasm and nuclei of the cells to an immediate bombardment by explosions of electrical atoms. We may, therefore, designate this internal treatment with radioactive substances, internal electrotherapy."

\* Read before the annual meeting of the American Pharmaceutical Association.



How steel darts are dropped from an aeroplane.

Insert on the left shows a dart about half size; on the right, the box from which they are discharged.

#### Aeroplane Darts and Fire Darts\*

EVEN before the war began, the French made many experiments in throwing missiles from aeroplanes. The best-known of these projectiles are small bombs or hand grenades, about as big as oranges, which are launched from tubes, or thrown by hand, at large terrestrial objects, and which explode on impact. Experiments were made also with a large bomb, or shell, which was slung beneath the aeroplane and dropped by casting loose its suspending cords. Not many of these large bombs, however, can be carried by an aeroplane.

A very different missile, the short steel dart, has been frequently used by French aviators during the present war. These darts are rods of pressed steel, about as thick as a lead pencil. Four grooves, extending through two thirds of the length, considerably diminish the sectional area and weight of that part of the dart and give the cross-section of the tail the form of a four-pointed star.

Hence the dart always falls with its heavy cylindrical and sharply pointed head directed downward. The darts are made in two lengths, about four and six inches, with corresponding weights of  $\frac{1}{2}$  and  $\frac{3}{4}$  ounce. They are thrown, with the aid of a special device, in bundles containing from thirty to fifty darts, but they promptly separate so that they are dispersed over an area of 5,000 square feet on striking the ground, when dropped from an elevation of about 1,500 meters, or 5,000 feet. This height of fall gives them a striking velocity of 200 meters (about 650 feet) per second, approximately that of a rifle bullet, so that they are able to inflict severe wounds.<sup>2</sup>

The effectiveness of these darts cannot yet be conclusively judged. In a case reported to me by eye witnesses, a shower of darts fell upon four companies encamped in a small space. One third of the darts found victims, and inflicted many severe and a few fatal injuries. The conditions were especially favorable for the attacking aviator, and this example should serve as a warning not to encamp several companies together. In another case I found that the darts had only slightly wounded a few men. One dart had struck a horse's rump, inflicting a painful flesh wound, but not disabling the animal.

Another aeroplane missile is the fire dart, devised especially for attacking and destroying airships. The experiments with fire darts that have been carried on at the Eiffel Tower and elsewhere in France since 1910 have resulted in the construction of a service type,

which will probably be employed in the present war. This fire dart is 16 inches long, 3.2 inches thick and 2.2 pounds in weight. It consists essentially of a tube containing one half pint of benzine and a stout steel needle. In falling, it is kept in a vertical position by the action of a little screw propeller at its upper end. When it falls on an airship the point of the needle, protruding from the lower end of the tube, pierces the gas bag, to which the tube is then held fast by six fish-hooks. The impact ignites an explosive mixture packed around the needle, and the benzine and the gas of the airship are ignited in rapid succession. I have not yet heard of the employment of these fire darts in the present war.

#### Philosophy and Technics\*

WE regard the triumphal progress of the natural sciences with justifiable pride. An immense fund of knowledge has been accumulated, problems that seemed hopeless have yielded to research, and upon the progressive understanding of the harmony of nature has been reared the imposing edifice of modern technics, the characteristic monument of our era. Although many important questions are still unanswered and extensive fields of knowledge have been only discovered, not explored, yet a sort of stopping point seems to have been reached. The recognition of this fact is manifested in the newly awakened interest in the history of science, and in the endeavor to take stock of the results hitherto accomplished and to attain a clear idea of the real value of science.

For the successes of science have not prevented the uplifting of voices warning against over-valuation of those successes. Skeptics have asked if the progress of chemistry and physics has brought us nearer to "the truth." Have we made a single step toward the understanding of the essence of things? The number of these critics is increasing and the expression "bankruptcy of science" is heard. Doubters have arisen in the ranks of science itself. It was a physicist who defined science as "economy of thought," a means of arranging for convenient reference the impressions with which we are stormed by our environment.

Technology appears now to be undergoing a similar development. To a superficial observer it shows splendid triumphs, the accomplishment of results unthought of a few decades ago. In the words of Lamprecht, it is "no longer an embryo, but a well-developed, beautiful, and strong personality in the zenith of its power." This maturity appears to be leading to introspection. We look away from the work in order to discover the true sense of technics, and this inquiry involves others, no less important, for which we have not hitherto had

leisure. Whence comes technics and whither does it lead us? Does it mean nothing more than the application of scientific discoveries to the solution of prosaic problems of utility? Is its sense exhausted in its economic value, in the satisfaction of the impulse toward self-preservation, in the chase after wealth and economic power? Or is it based on some idea higher than the principle of utility? In other words, is there a philosophy of technics?

In the year 1877 Ernest Kapp published a book, now almost forgotten, entitled "Outlines of a Philosophy of Technics." (*Grundlinien einer Philosophie der Technik*.) The author, who came from the camp of Hegel, endeavored to explain, from the anthropocentric viewpoint, the whole development of technics by unconscious "projection" of the human organism upon external things. In this theory the hand, arm, and jaw are the prototypes of the earliest tools and utensils. In the hammer the arm is prolonged and the power of the hand increased; the rigid forefinger with its sharp nail is imitated in the drill, the teeth suggest the file and saw, the hollowed hand is the pattern of the bowl. The parts of the body, especially the hand, project their dimensions and numerical relations also. The span, foot, etc., were the earliest units of measurement, and the ten fingers gave us the decimal system of notation. Even the movements of the limbs are repeated in machines, for levers, pendulums, axles, cords, and hinges are found in the human body.

Kapp's theory has been criticised by several writers. Eyth, one of the most philosophical of technicians, has objected that weaving, fire-making, and many other important technical arts cannot be explained by the projection of human organs. F. Reuleux has asserted, in his valuable treatise on the theory of machinery, that the most rapid progress in technics has been made where men have freed themselves from natural prototypes and tried "to solve problems by their own means, often radically different from those of nature."

To these critics it may be replied that imitation does not necessarily mean the production of a perfect likeness. Biology furnishes technics with elements which are employed in altered forms and combinations, conditioned by the nature of materials. For example, it is not a valid objection to the theory of projection to show that continuous rotation about a fixed axis does not occur in the human body. The movement of the arm in a circular arc about the shoulder joint contains the same element of motion that we find, developed and perfected, in the swiftly turning wheel of a machine.

We must, therefore, agree with Kapp that there is a remarkable similarity between mechanical tools and human organs. It is another question whether we shall also agree with him in regarding both as expressions of an unperceived metaphysical principle. Here the philosophy of technics becomes merged in the general problems of philosophy, and agreement or disagreement with Kapp will be conditioned by the viewpoint of each individual philosopher.

Metaphysical philosophy is not in great favor nowadays. Philosophy is continually becoming more practical. As "natural philosophy," it stands in intimate association with the natural sciences, or it seeks a connection with psychology, or it invades the field of ethics. In like manner the philosophy of technics has become a "philosophizing about technics," an introduction of psychological, social-ethical, and other problems into the field of thought of technics. These questions are discussed by Eberhard Zschimner in a recently published book (*Die Philosophie der Technik*), which is symptomatic of the changes that have occurred in the meaning and the valuation of technics. Zschimner sees in technics "the organic part of a greater phenomenon," namely, the development of civilization (*Kultur*). By extending the range of our senses and increasing our power over the forces and material of nature, technics assures to the human race the material freedom which it needs for the conscious, creative work of perfecting its development. Hence, the function of the technician is comparable with that of the artist, for each is devoted to the conscious realization of an impersonal idea. As the idea of art is unfolded in the experience and enjoyment of the artist's creation, so the idea of technics is realized in the experience and enjoyment of the material freedom, which the work of the technician gives to mankind.

Unhappily we are yet far distant from this ultimate goal of technics. Certain economic dissonances and certain forms of work, specialization and mechanization, are so conspicuous as the results of technical development that the ideal value of technics is difficult to recognize. But technics should not be held accountable for these unwholesome by-products. The object of a philosophy of technics is to prove that technics is something more than an arithmetical problem in national economy, and that its true value is unquestionably to be found in the subordination of personal interests to higher ideals.

\* Translated from the report of a war correspondent of the *Kriegstechnische Zeitschrift*.

<sup>2</sup> A consideration of the formula  $V = \sqrt{2gh}$ , and remembering that in the metric system  $g$  is about 10, shows that an altitude of about 2,000 meters would be required to produce a velocity of 200 met/sec, even in *vacuo*. A much greater height would be required to produce the same result in air.—EDITOR.

\* Translated from Dr. Guenther Bugge's article in *Prometheus*.



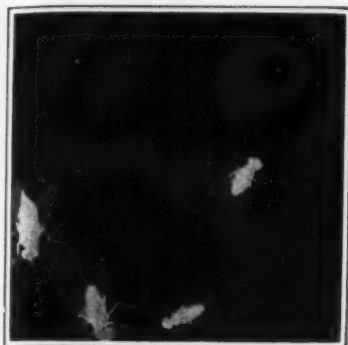


Fig. 1.—House-flies; an instantaneous photograph, made without a lens; exposure 1/90 seconds. Magnification 1.7.

### Instantaneous Photography Without Camera or Plate

An interesting note in the German journal *Prothetische* summarizes the account given by Prof. Dr. P. Lindner in *Mikrokosmos* of his experiments in instantaneous photography without camera or plate. The negatives were produced on gas-light paper by the use of parallel rays and the avoidance of all side lights. The source of light was daylight or, in photographing constantly moving living objects, a direct current arc-lamp, the rays of which were made parallel by means of a concave lens. The objects were placed in narrow, shallow glass dishes; and the short exposure was obtained by passing a piece of pasteboard with a slit in it before the dishes.

Ordinarily photographs without a camera are produced only by means of the Roentgen ray. Undeterred by the unusualness of the operation Prof. Lindner succeeded in obtaining his shadow-like photographs, in which the sharpness of the outline is as surprising as the simplicity of the method.

### Catalysis in the Gas Industry\*

WHEN the engineer appeals to the chemist for an explanation of certain reactions, and is answered that they arise from "catalysis," he is apt to hint that the reply masks a plea of ignorance. Frequently the suggestion is justified. At the same time some catalytic processes are as well understood as the chemist understands any reactions. The term "catalysis" was introduced by Berzelius in 1837; but Kirchhoff, Humphry Davy, Faraday, and others had quite recognized the peculiar character of the reactions long before that. That catalysis plays a great part in the gas industry might not at once be granted; but a little reflection will show that catalysis must come in, and Dr. R. Lessing certainly made out a good case for "Catalysis in the Gas Industry" when recently delivering the William Young Memorial Lecture before the North British Association of Gas Managers at Glasgow.

The definition of catalysis, for which Dr. Lessing expressed preference, was that given by Ostwald: "A catalytic agent is a material which affects the velocity of a chemical reaction without itself appearing in the final products." The definition, Dr. Lessing pointed out, implied that the reaction is possible even in the absence of the catalyst, and that the catalyst does not appear in the final product, though it may, and does probably, form unstable intermediate products which are decomposed and re-formed. This view is indeed the basis of one of the hypotheses offered for explaining the phenomena. The other hypothesis suggests absorption or occlusion of the reacting substances on the surface and in the pores of the catalyst, the acceleration of the reaction then being due to the higher concentration of the reagents, which may be solid, liquid, or gaseous. As regards coal and gas, Dr. Lessing remarked, there is scarcely a step in the course of the treatment which coal undergoes, from the mine to the burner or chimney flue, on which catalytic influences have not some bearing. In 1882 Abel suggested that "coal-dust exerts a contact or catalytic action upon gas mixtures similar to that possessed by platinum." There is a kernel of truth in that suggestion, though it does not cover the whole range of the phenomena of coal-dust explosions. The occlusion of methane, oxygen, and other gases by the large surfaces of the carbon particles would facilitate not only explosive combustion, but also spontaneous combustion. The older view attributed spontaneous combustion and gob-fires chiefly to the presence of pyrites; modern chemistry inclines to the belief that the constitution of the organic matter is often itself sufficient to render spontaneous combustion possible, and that the minerals act more as catalysts than as the primary cause. Dr. Lessing mentioned in

\* From *Engineering*.

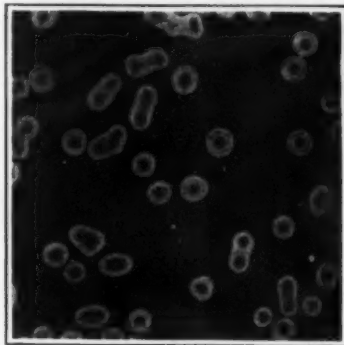


Fig. 2.—Vegetative growths of a form of bacteria from an analysis of water; gelatine culture in a Petri tube. Magnification 1.7.

this connection some recent work by K. A. Hofmann, Schlumpelt, and Ritter; they found that even retort carbon and lamp-black can be oxidized at temperatures below the boilingpoint of water by dilute solutions of potassium chlorate when catalytically activated by osmium trioxide or by solutions of bleaching powder.

If coal is subject to catalytic influences at ordinary temperatures, at which it appears chemically inert, it stands to reason that these influences will exert themselves strongly at the high temperatures of carbonization, considering the complexity of the organic coal substance, which always includes mineral matter. All the primary products from coal suffer decomposition on coming in contact with the hot retort-walls or hot coke. If the walls themselves have such an effect, the physical structure and the chemical composition of the retort-walls may be expected to have an influence; it would be of interest, therefore, to try glazed and unglazed retorts, and retorts made of silica, highly aluminous fire-clay, and iron. These influences will not be great, probably; for the retort will generally be covered by deposited carbon; yet experiments would be instructive. In addition to the ordinary thermal decomposition, there are taking place, in the retort, oxidation, dehydration, decomposition of heavy hydrocarbons, formation of benzene and other ring compounds, reduction or hydrogenation—all processes which, Dr. Lessing suggested, from the analogy of cognate reactions, the mineral constituents may well affect catalytically. These processes do not take place in any fixed sequence, of course; most of them are reversible and overlapping, and it is therefore very difficult to "disentangle the threads" and to trace the influence of any particular catalyst. But that the influences exist is sufficiently shown by Cooper's coal-liming process, which has so successfully been revived by R. O. Paterson of Cheltenham. The addition of a minute quantity of lime to the coal does away with stopped ascension-pipes and with "scurfing" troubles, that is to say, the trouble experienced in removing the deposited carbon from the retort-walls. Hempel ascribed the peculiar hardness of coke to the formation of silicides like carborundum, from the silica and carbon, during carbonization. Others have proposed to neutralize the activity of a highly siliceous ash by lime. Too little is, unfortunately, still known about the conditions in which mineral matter occurs in coal to speak definitely on such problems; the different constituents would interact in the retort, but the analysis of the ash does not tell much about the compounds originally present. How it comes about that the coal-liming process increases the yield in ammonia, and diminishes the formation of organic sulphur compounds, was explained in 1902 by the researches of G. T. Bellby and G. G. Henderson. They proved that metals like iron, copper, silicon, etc., take up nitrogen from ammonia at high temperatures, forming nitrides, which are decomposed again by steam with liberation of ammonia, and coals of different ash contents differ indeed in their ammonia yield.

Again, Dr. Lessing continued, catalysis is important in water-gas production. While coke to which 10 per cent of lime is added gives a gas containing 88 per cent of hydrogen and 12 per cent of methane, the addition of 50 per cent of lime will yield a gas with 77 per cent of hydrogen and 23 per cent of methane. P. Sabatier, one of the most conspicuous workers on catalysis of our time, found, in conjunction with Senderens, that both carbon monoxide and carbon dioxide could be hydrogenated into methane by the aid of hydrogen and of finely-divided nickel at a temperature lying between 200 deg. and 250 deg. Cent. Much hydrogen is, however, required for this formation of methane—more hydrogen than water-gas contains. The future of this reaction thus depends upon the cheap generation of hydrogen, itself mostly a catalytic process. That the purification from sulphur of coal-gas by iron oxide is essentially catalytic hardly needs emphasis; the iron first binds the sulphuretted hydrogen, and the sulphide

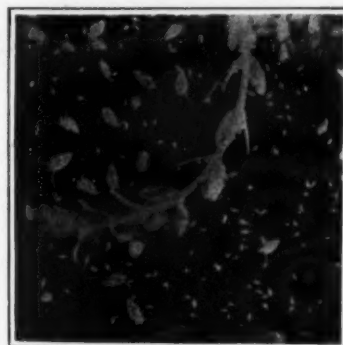


Fig. 3.—Daphnia and Cyclops swarming around a twig of *Elodea Canadensis*; exposure 1.90 seconds. Magnification 1.7.

is by the air again oxidized, so that the iron oxide is restored, and sulphur is deposited. If this sulphur, which blocks up the passages between the oxide particles, could be extracted by some solvent, which should not be volatile, the process would be perfect. The removal of the organic sulphur and of the carbon bisulphide from the crude gas is, or was, a still more difficult problem. The latter difficulty has quite recently been overcome by the catalysis, on a grand scale, of Charles Carpenter, in conjunction with Evans and Franks, by means of hydrogen in the presence of nickel at 430 deg. Cent.

We will not follow Dr. Lessing in his references to catalysis in relation to by-product works and to methodical "cracking;" it would lead us too far into chemistry. What we have said will suffice to show how important a part catalysis plays in the coal-gas industry. Much has been gained by systematic research, and a great deal remains to be investigated; the field is manifestly one for systematic scientific study.

### Coal the Big Item\*

THE largest single item in the operating costs of any steam power plant is coal. In most plants the purchase of coal is a matter of careful consideration, and in the larger ones it is usually bought under specifications. Once the coal is in the bunkers, this careful consideration stops and the actual burning of the coal is very rarely given more than a passing thought, as long as the steam pressure is kept up.

The men employed are paid the lowest possible living wage and are chosen more on the basis of the wages they will work for than the results they are able to produce. The man who burns the coal can easily vary the efficiency of the boiler by 10 to 15 per cent, or the heat absorbed by 15 to 20 per cent, yet he is at the bottom of the payroll.

No revolutionary advancement has been made in power plants recently, and the increased efficiency is accomplished only by taking each process separately and bringing it up to the highest standard. It would therefore seem wise, in attempting to increase the overall efficiency of a plant, to start with the item that represents the largest expenditure and work down the list.

In office-building plants the cost of coal represents some 35 to 40 per cent of the total expenses and boiler-room labor 12 to 15 per cent. In big plants the cost of coal is 50 to 55 per cent and the boiler-room labor 7 to 8 per cent. Take a concrete case of a certain office building in New York city that employs two firemen at \$600 a year each. Their coal costs approximately \$10,000 a year. If we assume that the boiler efficiency is 60 per cent, and that by paying \$900 a year men could be obtained who would operate the boilers at an efficiency of 70 per cent, it would be a paying investment. The increase in wages is \$900 a year. The increase in boiler efficiency amounts to a reduction in coal burned of 14.3 per cent, or \$1,430. The net result is \$530 to the good by the change—not a matter of philanthropy.

Any plant owner can figure out for himself what a small increase in the boiler efficiency will amount to in dollars and cents, and may find it profitable. The efficiency of the boilers may be increased in several ways, but first, proper equipment must be furnished. Every boiler plant should be equipped with a draft gage, stack thermometer, and means for determining the CO<sub>2</sub>. The cost of this whole equipment need not exceed \$100, which would be repaid in a very short time.

Then the firemen should be taught the use of this apparatus to determine the proper method of handling the fires to secure the highest efficiency. A bonus system for savings over a certain amount would probably be productive of the best results. If the firemen are able to save the plant money by their efforts, they should logically be entitled to a part of it.

\* From *Power*.

# The Gas from Blast Furnaces—III\*

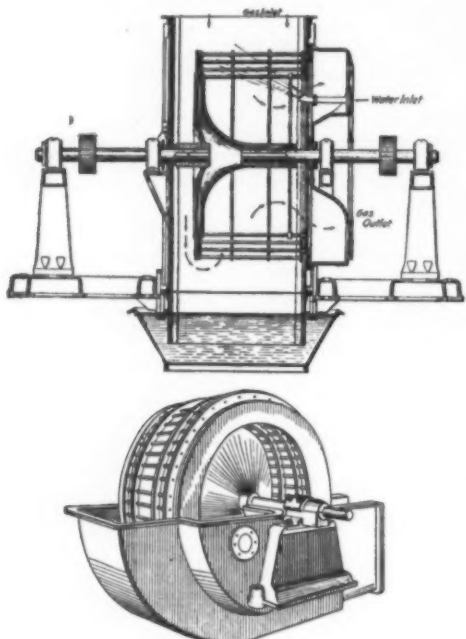
## Its Cleaning and Utilization

By J. E. Johnson, Jr.

Continued from SCIENTIFIC AMERICAN SUPPLEMENT No. 2041, Page 112, February 13, 1915

### SCHWARZ-BAYER DISINTEGRATOR GAS WASHER.

THE Schwarz-Bayer system of gas cleaning makes use of the disintegrator principle, and its general arrangement is simple. The complete set of gas-cleaning apparatus consists of a disintegrator in connection with a saturating chamber in the form of a hood; then a fan placed immediately behind the disintegrator, and finally a water separator. In case both primary and final cleaning are desired, two such sets of apparatus are used, the second of which further cleans the gas which has been primarily cleaned in the first.



Figs. 19 and 20.—Schwarz-Bayer disintegrator gas washer.

The disintegrator, as shown in Figs. 19 and 20, consists substantially of two sets of steel pins, cold-riveted to two steel disks, which disks are set side by side and revolve in opposite directions. The pins of one revolving disk, which interlace with the pins of the other revolving disk, form with the water, through the effect

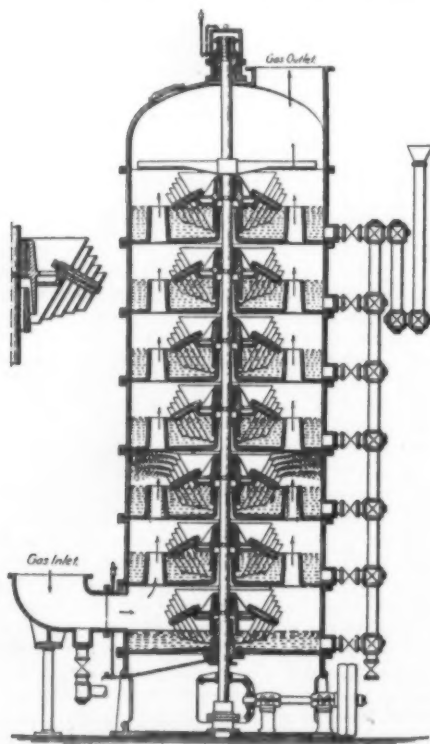


Fig. 22.—Feld gas washer.

\* Reproduced from Metallurgical and Chemical Engineering.

of rotation and dripping, a fine spray or mist, which allows a thorough mixture of the water with the gas traveling among and between the pins before leaving the apparatus.

The gases from the blast furnace pass from the raw gas mains directly into the disintegrators without previously passing through Zscheoke towers or similar preliminary washer or cooler. The gas enters through the top of the hood and passes toward the center of the disintegrator, while water is being introduced through the sides to the center. The hood acts to some extent as a pre-cleaner and cooler, as some of the spray from the disintegrators is thrown into the hood and there comes in contact with the hot gas and rapidly evaporates, simultaneously cooling the gas. By the revolution of the disintegrator the water is projected toward the periphery of the apparatus and is broken up into a fine spray; the gas mixes thoroughly with this water and is cooled, and most of the dust contained in the gas is precipitated. The gases pass through the disintegrator in a current counter to that of the water.

The application of the counter-current principle enables the gas to encounter cleaner and colder water in its passage through the disintegrator; hence it is better cleaned, and its temperature is reduced more nearly to the temperature of the entering cooling water. This principle has the effect of materially reducing the amount of water and power consumed. Each disk is direct driven by an individual motor and the speed is determined by the degree of cleanliness desired in the gas. The gas is drawn through the disintegrator by means of a fan located immediately behind the disintegrator apparatus, and passes from the fan to a water separator.

The use of pins in this apparatus as a disintegrating medium allows the passage of the gas with very little resistance, and a consequent saving in power. There is also very little possibility of the dust settling on the pins and clogging up the apparatus.

### FWLER & MEDLEY VERTICAL GAS WASHER.

This apparatus, as shown in Fig. 21, consists of a circular cast-iron casing containing a revolving shaft running vertically through the middle. On this shaft are fixed a number of disks, made either of steel or of cast iron, depending upon whether the water used is alkaline or acid. Each disk is equipped with a collar separating it from the adjoining disks, and each collar is punched or drilled with six holes, through which six bolts pass vertically, thus holding all the disks in place. The shaft is direct driven with a vertical-spindle motor. Two fixed water sprays are provided for each disk, diametrically opposite each other, one on each side of the washer and projecting between each pair of disks. The jets of water, which are introduced through nozzles having about 1/8-inch openings, enter with sufficient pressure to strike the collar between the disks, and, as the disks revolve, the water is thrown against the top and bottom of these disks and then against the outside wall of the casing, creating a fine spray or mist in the space between the outer edge of the disk and the wall of the casing, through which space the gas passes. The gas enters the washer at the bottom, passes through this spray or mist, and leaves clean at the top.

This washer can be used for either primary cleaning or final cleaning, or both; in case final cleaning is desired, two washers would be used in series, the first apparatus to clean the gas sufficiently for primary purposes and the second apparatus to finish the cleaning of the gas for gas-engine use.

### FELD GAS WASHER.

The Feld washer, as shown in Fig. 22, consists of a series of superimposed sections, the bottom of each section being provided with ports for the passage of gas. The gas enters the bottom of the washer and passes from chamber to chamber to the top, whence it is led away. Each section or chamber is provided with a series of cones perforated at the top and mounted upon a cast-iron spider, which is carried on a vertical shaft. The shaft is suspended at the top in a specially designed anti-friction bearing, arranged so as to reduce the power required for operation to a minimum. The water is admitted into the top of the washer and overflows from section to section through the gas ports, the dirty water saturated with dust leaving the bottom of the washer.

When the shaft revolves, the cones do likewise, and the water is raised by centrifugal force along the in-

ner sides of the cones and is atomized at the upper edge. This upper edge of each cone is a little higher than the next outer one, thereby forming a certain number of horizontal sprays of water, depending on the number of cones. The upper portion of the outer cone, which is somewhat higher than the inner one, is perforated. The inner cones supply water to the perforated surface of the outer one. This results in the formation of a series of cascades composed of very small drops of water, through which the gas must pass en route through the apparatus.

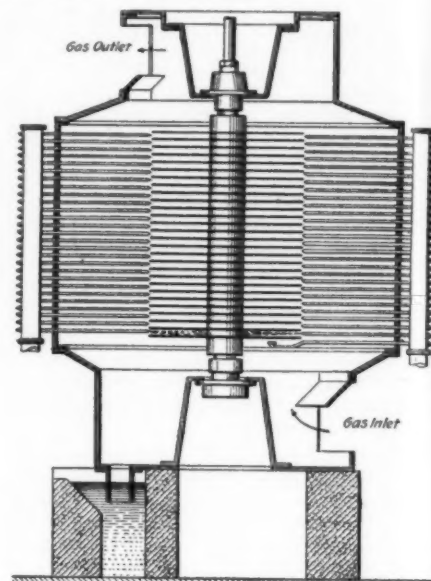


Fig. 21.—Fowler and Medley vertical gas washer.

The washing is accomplished mostly in the lower sections, while the upper sections perform primarily the function of cooling the gas.

For primary washing, the Feld washer is constructed with seven chambers or sections, the lower three being the washing chambers, the fourth one being a separating chamber and the upper three being the cooling chambers. For final washing, in the case of the gas being required for gas-engine purposes, the gas, after being primarily cleaned, is passed through an additional washer of the same general arrangement.

### RECO CENTRIFUGAL GAS WASHER.

This gas washer is constructed by the Roessing-Ernest Company, of Pittsburgh, Pa., and is designed to cool, clean, and, if necessary, dry the gas in one apparatus. This washer consists substantially of a vertical outer casing, a tube whose lower end is provided with serrations extending to within a few inches of a water seal, a revolving inverted cup, and a sleeve casing at-

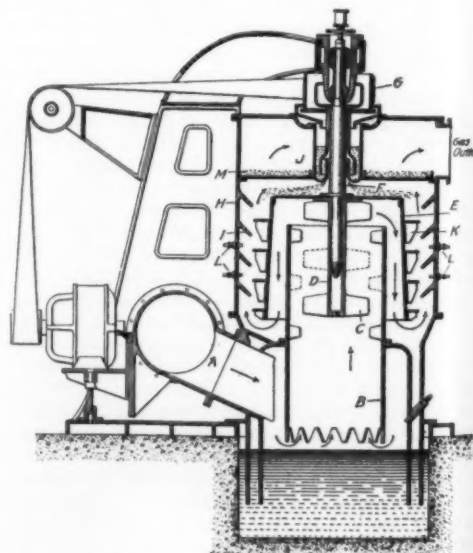


Fig. 23.—Reco centrifugal gas washer.



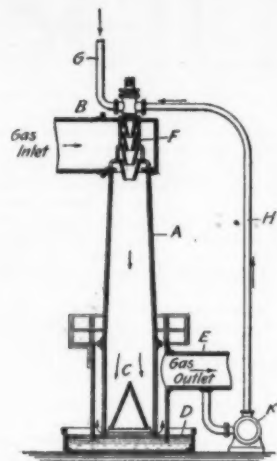


Fig. 24.—Sepulchre gas washer.

tached to the inverted cup. The outer casing, the cup, the tube, and the sleeve casing are provided with shelves and vanes. The apparatus is belt-driven. The spindle of the rotor on which the driving pulley is fastened is hollow, and the weight of the rotor is taken up by the shaft inside of this sleeve held by a ball bearing which is backed by a rubber buffer in order to equalize any irregularities during rotation.

As shown in Fig. 23, the hot gas enters the apparatus at the point A, passes over the water, a certain amount of which the gas takes up by evaporation, and then passes into the tube B through the serrations at its base. During its passage through this tube the gas and water vapor are subjected to a thorough beating and mixing by the action of the vanes C of the revolving sleeve casing D, fastened to the top of the inverted cup E. The gas passes into this inverted cup, which is rotated by the driving sleeve F and the pulley G, and then flows downward, around and under the lower edge of the cup and then upward between the cup and the

clean primarily cleaned and cooled gas to the degree necessary for use in gas engines. The principle of this system consists in creating in a vertical tower a very fine spray or mist of water by means of an injector of the Körtng type, in which water under pressure is atomized by means of compressed blast-furnace gas, the spray being produced by the expansion of the compressed gas. An intimate mixture of the spray so formed, with the dirty gas entering the apparatus, is obtained by the arrangement of the apparatus.

A separator is provided in connection with this apparatus, which consists substantially of a cone arranged in the lower part of the tower in such a way as to leave between the base of the cone and the walls of the tower a very narrow passage, through which the gases are forced over the surface of a water seal, where the dust and water vapor are deposited.

In the accompanying drawing, Fig. 24, A is the vertical tower, the lower end of which terminates a short distance above the surface of the water seal D. Within the lower end of the tower is arranged a conical deflector C, and near the top of the tower is the gas inlet B. The lower section of the tower is surrounded by a casing which is open at the bottom and extends beneath the surface of the water in the seal. A gas outlet, E, is provided in connection with the outer casing. The Körtng injector is located at F and the feed water for same is supplied through the pipe G. The pressure is supplied by withdrawing a portion of the purified gas from the outlet pipe E and forcing this, by the compressor K, through the pipe H into the injector simultaneously with a stream of water.

#### FINAL DRY CLEANING.

(Some of these systems can also be applied to primary cleaning).

#### HALBERGER-BETH GAS-CLEANING SYSTEM.

The principle of the Halberger-Beth system, shown in Fig. 25, is based primarily on filtering the gas through canvas bags. The gas coming from the blast furnace passes through the usual dust catchers and gas mains to a cooling tower, where the temperature of the gas is reduced to about 175 deg. Fahr. The cooling tower is arranged so that the necessary amount of cooling can be accomplished either by air or by direct contact with

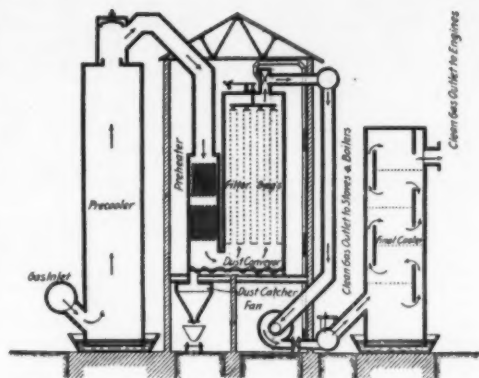


Fig. 25.—Halberger-Beth gas-cleaning system.

gress, and cleaned gas, superheated to the proper temperature of about 175 deg. Fahr., is forced under pressure into the compartment. This causes a partial collapse of the canvas bags, which, in conjunction with the simultaneous shaking, allows the dust to fall from the canvas. The separated dust drops into a hopper beneath the sacks, whence it is transferred by means of a spiral conveyor to a bin, from which it is loaded into cars. At the end of the cleaning period the butterfly valve automatically returns to its original position.

It is quite necessary to keep the temperature of the gas at about 175 deg. Fahr., as if much higher than this there is danger of scorching the bag, while if lower the water vapor in the gas is deposited on the canvas and prevents proper filtration. In case the gas becomes cooled below 175 deg. Fahr. in the cooling tower, it is superheated by means of steam or by waste heat from the hot-blast stoves to about this temperature before entering the filtering bags. After leaving the canvas bags, the gas requires no further cleaning for gas engines and is cooled down to the proper temperature in cooling towers of various designs.

The degree of cleanliness of the gas is indicated by the clearness of the effluent water from these towers and no settling basins are required. Consequently, this water can be used over and over again, which is a material item in districts where water is scarce. A further advantage lies in the non-pollution of streams, the laws relating to which are very strict in certain districts.

This system utilizes the basic principle employed in the "bag house" system, which has been used for the last 20 years in connection with recovering zinc dust from the gas issuing from zinc oxide furnaces and collecting dust from lead smelters.

#### THE KAPNOGRAPH.

This instrument, shown in Fig. 29, continuously indicates the relative degree of cleanliness of the blast-furnace gas going to the gas engines, and is extensively used in European gas-engine stations. Gas from the cleaned gas main passes through this apparatus and impinges upon a continuous recording chart, upon which the dust in the gas is deposited. The variations in the amount of dust in the gas are indicated by lighter or darker shades on the recording paper, depending on the amount of dust deposited. The flow of gas to the instrument is maintained either by the natural pressure of the gas, or, if this is not sufficient, by an aspirator behind the outlet pipe. The speed of the gas to the nozzle is kept constant by means of a regulator, as shown in sketch, the excess gas over the required amount escaping into the outlet pipe by passing under a partition and through a seal of water.

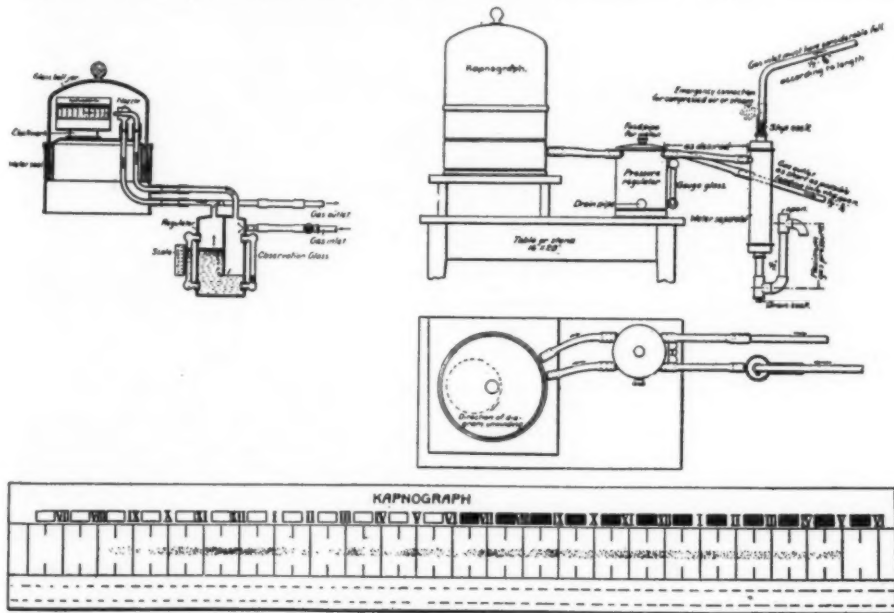
(To be continued.)

#### A Unique Hydraulic Plant

A NOVEL power plant for supplying electric lighting has been put in operation in Australia. The water power is derived from an artesian well from which the water issues under great pressure. When shut down this pressure reaches 270 pounds; and the working pressure of the jet is 190 pounds. This pressure is utilized in two Leffel wheels, which drive two dynamos, each of 10 kilowatts capacity, which supply current to a direct-current two-wire system, comprising eighty 50 candle-power metal-filament lamps, the number of consumers being twenty-five, and the voltage at consumers' terminals 200 volts.

#### Utilizing Old Equipment

AN ingenious way to utilize old equipment was recently devised at a power station plant in Kansas. Owing to additions made to the plant a larger smokestack was required, and when it was completed the old stack, which was of steel, 8 feet in diameter and 200 feet high was cut down to a height of 25 feet, and the lower part reinforced by boiler plate. All openings were closed and tightly calked, and the old chimney was thus converted into a very efficient water tank at a trifling expense.



Specimen of strip indicating one day's run at a European Gas Engine Plant.

Fig. 29.—The Kapnograph.

outer casing H. The outer surface of the revolving cup is provided with concentric shelves K and the outer casing H is provided with downwardly inclined shelves I, which receive the washing water from the water-sealed stuffing box J and through a series of water pipes L. The water, falling on the rapidly rotating shelves of the cup, is thrown by centrifugal force against the inner walls of the casing and thence flows downwardly along the inclined shelves, dripping on to the next rotating shelf, and so on. In this way the gas, while subjected to a thorough whirling and beating action, has to pass upward through several films of finely divided water or spray while the water passes downward, carrying with it the separated impurities.

The apparatus operates on the counter-current principle, the cleanest gas passing from the apparatus meeting the cleanest water entering the apparatus.

The upper part of the casing is provided with a rack which, it is stated, can be packed with suitable drying material in case it is desired to dry the gas before leaving the apparatus.

#### SEPULCHRE GAS WASHER.

This system is designed as a final washer to further

water, depending on the temperature of the gas entering the cooler, which temperature is naturally variable, in accordance with blast-furnace conditions.

From the cooler, the raw gas, by means of the suction of a fan placed beyond the filters, or without a fan when the pressure of the gas issuing from the furnace is sufficient, passes into and through the canvas filtering bags, depositing its impurities on the surface of the bags. These canvas filters are contained in a series of double compartments, each usually holding twelve canvas bags in rows of three to four. Each bag is about 8 inches in diameter by 9 feet 9 inches long, and is equipped with a ring at each 18 inches of its length to prevent entire collapse of the bag when cleaning. The bags are fastened into a stationary header at the bottom, this bottom end being open, while the top is closed by a steel plate. Each bag is connected with a shaking mechanism located outside and above the filter compartment, and at regular intervals, usually about every 4 minutes, these bags are automatically shaken, a compartment at a time, for a period of from 15 to 20 seconds. By means of a butterfly valve, the uncleaned gas is shut off from the compartment while the shaking is in pro-



## NEW BOOKS, ETC.

**ASSAYING IN THEORY AND PRACTICE.** By E. A. Wright. New York: Longmans, Green & Co. 8vo.; 323 pp.; illustrated. Price, \$3 net.

Laboratory determinations naturally usurp the preliminary pages of Prof. Wright's useful handbook. In the following divisions of the work the author, while disavowing any claim to exhaustiveness, gives us sound and practical descriptions of dry and wet assaying and of cyanide and mill tests. The book issues at the request of his past students of the Royal School of Mines, and will prove to them and to other assayers a great aid in the efficient performance of their duties and a detector of the sources of error in their determinations. There are plans of laboratories, lists of required apparatus, tables and conversion factors. Prof. Wright desires the work to be considered in the light of an experiment, to be followed in the event of success by a second volume dealing with more complicated analysis. The wisdom of many living authorities is embodied in the text, and in both text and illustration skill and thoroughness are exemplified.

**LINEN.** From the Raw Material to the Finished Product. By Alfred S. Moore. New York: Sir Isaac Pitman & Sons, Ltd. 12mo.; 132 pp.; illustrated.

Uniform with the other volumes of the "Common Commodities of Commerce" series, this monograph attracts our attention with a frontispiece in color showing a field of flax in bloom. The Irish linen trade is sketched as it was in the past and as it is to-day. The linen manufacturing system in its various aspects is presented in accurate, semi-popular style, and there is a description of the mode of marketing. The condition of the operatives is briefly referred to. The author has so combined condensation with comprehensiveness that, slim as the volume is, it holds a treasury of information.

**PRINTS.** A Brief Review of their Technique and History. By Emil H. Richter. New York: Houghton Mifflin Company, 1914. 8vo.; 138 pp.; with illustrations. Price, \$2 net.

In "Prints" we are given a charmingly artistic volume that cannot fail to delight any to whom pictures appeal. The subject is rich in historic and artistic lore, and its possibilities have been taken full advantage of by the author and the publishers. The work is not intended for the connoisseur, who has an elaborate literature at his disposal, so much as for the public who are taking an increasing interest in the broader aspects of the subject. As an introduction to the graphic arts it is everything that could be desired. It deals with the making of prints, the origin of woodcut, the early days of engraving, and the activities of Italy, Germany, the Netherlands, France, England and the United States. Its many illustrations, reproductions toward which great painstaking is manifested, are typical of the best and most representative work of the old and the later masters.

**AN INTRODUCTION TO THE STUDY OF FOSSILS.** (Plants and Animals.) By Hervey Woodburn Shimer, A.M., Ph.D. New York: The Macmillan Company, 1914. 8vo.; 450 pp.; illustrated. Price, \$2.40 net.

It is necessary that students bring to the study of paleontology at least such knowledge of biology as will enable them to take up fossils intelligently. Prof. Shimer's text-book of introductory paleontology has been planned with this need in view. It takes up the living forms as types and proceeds to a consideration of their response to environment, thus training the observation to reconstruct the living form from the fossil. It gives a comprehensive glimpse of life in the present, and of its use in the interpretation of the records of the past. Many authorities and institutions have contributed illustration and criticism, and the result is a work that may be placed in the hands of the student with confidence in its accuracy, and in its adaptation to the requirements of preliminary study.

**CORK.** Its Origin and Industrial Uses. By Gilbert E. Stecher. New York: D. Van Nostrand Company, 1914. 8vo.; 83 pp.; illustrated. Price, \$1 net.

Its wide application and its unique characteristics make cork an interesting subject of study. Mr. Stecher gives us a plain narrative of operations from the corkwood of the forest to the cork of the cellar and the kitchen. It may surprise the general reader to learn that so familiar a thing has a name shrouded in mystery. Its origin leads us to the romantic shores of the Mediterranean. But we have said enough to indicate that this is a very readable monograph, which continues its investigations through the botany and chemistry of the substance, through the processes of its manufacture, on to its many uses and applications.

**ZOOLOGICAL PHILOSOPHY.** An Exposition with Regard to the Natural History of Animals. By J. B. Lamarck. Translated, with an Introduction, by Hugh Elliot. New York: The Macmillan Company, 1914. 8vo.; 410 pp. Price, \$4 net.

Lamarck's theories and observations still possess something more than historic interest, and it pleases us to see so adequate a translation of his great work. To such a man as Hugh

Elliot we have a right to look for sterling work and an illuminating summary; neither in his translation nor in his masterly introduction has he disappointed us. The papers of Lamarck deal with the varied organizations of animals and the faculties derived from them; with the physical maintenance of their life and the incitations to their interesting behavior; and to the higher feeling and intelligence noted among the higher orders. Lamarck is greatly quoted and little read. The latter due, doubtless, to the obsolete, redundant, exasperating mode of expression. This the translator has carefully corrected, without destroying in the least any vital presentment of the work. In zoology Lamarck held that, all living species being known, a linear series would be disclosed each of whose members differed so slightly from their immediate neighbors that the gradations would be almost imperceptible. The large gaps which exist he attributes to undiscovered species. His translator discloses the errors of his system while frankly acknowledging its ingenuity. Lamarck rendered a distinct service to classification, and his errors are rather the natural result of the restricted knowledge of his time than any lack of observation or of perception. His zoology, physiology and psychology are always most interesting, and deserving of the wider appreciation this translation would seem to assure him.

**THE DAWN OF CHRISTIANITY.** By Alfred W. Martin, A.M., S.T.B. New York: D. Appleton & Co., 1914. 12mo.; 221 pp. Price, \$1.25 net.

A sequel to "The Life of Jesus in the Light of the Higher Criticism," this series of lectures deals with the formation of the New Testament, the influence of Paul, and the crystallization of the existing religion into what we now know as Christianity.

**THE BOOK OF DESTINY.** And the Art of Reading Therein. By Grand Orient. Philadelphia: David McKay. 12mo.; 280 pp. Price, \$1.

**THE OCCULT ARTS.** By J. W. Frings. Philadelphia: David McKay. 12mo.; 236 pp. Price, \$1 net.

**COSMIC SYMBOLISM.** Being a Discussion and Exposition of Some Recondite and Obscure Points in the Art of the Kabalists, the Mysteries of Sound, Form and Number, and the Basic Principles of Cosmic Symbolism. By Sepharial. Philadelphia: David McKay. 12mo.; 296 pp. Price, \$1.25 net.

**A MANUAL OF OCCULTISM.** By Sepharial. Philadelphia: David McKay. 12mo.; 368 pp. Price, \$1.50 net.

Take any golden stiletto that may be lying around, prick any number haphazard upon the chart of fortune, and Grand Orient will answer your question through his "Book of Destiny." Pure rubbish, of course, whose only claim upon our leniency must be upon the score of its age. In "The Occult Arts" J. W. Frings attempts to justify "some of them," as he cautiously puts it, by the conclusions of modern science. He abjures the supernatural, and he knows how to write. In fact, he writes so well that the broken link between the occult and the scientific is usually concealed with great skill. In the last two books on this occult list, we find that "Sepharial" is a man to be reckoned with, inasmuch as his knowledge of modern research seems to be as broad as his wisdom in astrology, and his work is apt to influence minds with a tendency toward mysticism. In "Cosmic Symbolism" we are told that the horoscope of Capt. Smith, of the "Titanic," and of W. T. Stead, both point to such a death as overtook them. But as to the horoscopes of the vast throng who shared their fate he is silent. Some of the horoscopes must have read oppositely—or would he have us believe that Capt. Smith and Mr. Stead were astrological Jonahs? "A Manual of Occultism" by the same author is a good exposition of the methods of astrology, palmistry, and many other pseudo-sciences, and shows a mentality and an application that might have been put to good use in a practical cause.

**THE WONDER OF LIFE.** By J. Arthur Thomson, M.A., LL.D. New York: Henry Holt & Co. 8vo.; 658 pp.; illustrated. Price, \$3.50 net.

This is "an unconventional introduction to Natural History and Biology, taking broad views of the actual lives of living creatures and working inward." In spite of the advance of Science, Nature's eyes are still full of unfathomable mystery, and it is the sense of this mystery which the author would convey and heighten. The many colored plates are exquisitely conceived, and are mounted upon a dark background that gives an air of distinction to the whole volume. Here are the bird-catching spider, the mussel with its precious freightage, the death's head moth, and the sea-horse threading the branching red coral. The text is quite enthralling, and no better book could be placed in the hands of young nature students. Huxley's translation of Goethe's aphorisms fitly brings this recital of marvels to a close.

**THE GERM-CELL CYCLE IN ANIMALS.** By Robert W. Hegner, Ph.D., Assistant Professor of Zoology in the University of Michigan. New York: The Macmillan Company, 1914. 8vo.; 346 pp.; illustrated. Price, \$1.75 net.

New and important facts in hereditary are being unearthed from time to time, and many of these additions to our knowledge are directly

due to researches in cellular biology. Prof. Hegner has taken for his theme the life history of the germ-cell, and chiefly of the germ-cell as it appears in animals. Condensation has been imperative, so that certain phases have been but lightly touched upon, while those with which the author is most familiar personally are justifiably stressed. He has couched his explanations in such language that the reader may derive from them an intelligent satisfaction even though he be unacquainted with the recent progress of cytology. The period in the life of the germ-cell which the author has chosen to emphasize—partly because it has been more or less neglected—is that of the segregation of the cells in the developing egg and the visible substances concerned in the process. Prof. Hegner's original investigations are largely embodied in the text. The germ-plasm theory is expounded in a separate chapter, and a long bibliography is appended.

**STEAM POWER PLANTS. A Treatise for Designing and Constructing Engineers, Architects and Students.** By Charles L. Hubbard, B.S., M.E. New York: McGraw-Hill Book Company, Inc., 1914. 8vo.; 299 pp.; illustrated. Price, \$2.50 net.

**HEATING AND VENTILATING PLANTS.** By Charles L. Hubbard, B.S., M.E. New York: McGraw-Hill Book Company, Inc., 1914. 8vo.; 308 pp.; illustrated. Price, \$2.50 net.

These volumes are Parts I and II of a series on Power, Heating and Ventilation, of which Part III, "Isolated Plants and Small Groups," is in press. Each volume is complete within itself, cover design, construction and management, and treats the fundamentals of its subject in such a way as to render the work valuable as a textbook for students. Part I deals with heat, steam, fuels and combustion, boilers, furnaces and chimneys, steam engines and turbines, with the details of power plant design. Part II discusses principles, sets forth the advantages and disadvantages of hot air, hot water, steam, and electric systems of heating, and reviews methods for the heating and ventilation of special types of buildings. The final chapter is devoted to the care and management of plants. The text is interspersed with useful tables and is well and generously illustrated.

**HANDBOOK OF THE ROCKY MOUNTAINS PARK MUSEUM.** By Harlan I. Smith. Ottawa: Published by the Department of the Interior, Dominion Parks Branch, of Canada.

This museum is located at Banff, Alberta, and is intended eventually to fully illustrate the natural history of that portion of the Rocky Mountains lying in Alberta and British Columbia; and the handbook presents in book form the labels of the museum as already printed, and some that are yet to be printed; and when finally completed, in some future edition, will constitute a convenient and popular reference list and description of the chief outstanding natural history objects of the region.

**NORTHERN PATAGONIA. Character and Resources.** Vol. I. Text and maps by the Comisión de Estudios Hidrológicos. Bailey Willis, Director, 1911-1914. New York: Scribner Press. 8vo.; 464 pp.; illustrated. Price, \$6 net.

This work is a credit to the Commission under whose auspices it issues. It is an admirable description of the Rio Negro-Chubut region, and of the topographical, geologic and economic surveys made by the Commission during 1911-1913. These surveys originated in a national policy of railroad construction which was designed to open up the rich and extensive territories of northern Argentina. This is the primary step toward the greatly enlarged prosperity which must follow on the accessibility of such varied resources, and speaks volumes for the foresight and practical energy of the administration. In our own country, where a similar lack of water was encountered, geological survey relieved the situation by the discovery of artesian supply; and it is our own geologists who, secured by Dr. Ramon-Mexia, must receive recognition for the advantages gained by the field work and the scientific methods used in attacking the problems of Patagonia. The text includes numerous plates of extraordinary beauty, and besides the charts of the volume proper thirteen sheets of maps are provided in a separate case which is bound in uniformity with the text.

**JAHRBUCH DER WISSENSCHAFTLICHEN GESELLSCHAFT FÜR FLUGTECHNIK, II. Band 1913-14.** Berlin: Verlag von Julius Springer, 1914. 4to.; 183 pp.

The society which issues this valuable yearbook was founded at Berlin, April 3rd, 1912, and its membership includes the leading exponents of scientific aeronautics in all parts of Germany. Its honorary president is Prince Henry of Prussia. The meetings of the society are devoted to the consideration of all kinds of scientific and technical questions relating to aeronautics, and usually include lectures by specialists, followed by a general discussion. Both the lectures and the discussions are published in the yearbook, each volume of which has appeared in two parts, or "Lieferungen." The society has a number of committees on special subjects, such as aerodynamics, motors, safety devices, medical and psychological questions, aerology, electrostatics, etc., the reports of which are briefly abstracted in the yearbook. In short, this publication is indispensable to the student of aeronautics. The volume under review includes

all the lectures delivered before the society during the year 1913, with discussions; viz., "Motor systems," by Prof. Baumann; "An Apparatus for investigating wind-structure—the anemoclinograph of the Siemens & Halske Company," by Dr. H. Gerding; "Legal questions in aeronautics," by Dr. Erythropel; "The study of the upper strata through the organization of an international network of pilot-balloon stations," by Prof. P. Polls; "Aeronautics and mechanics," by Prof. A. Proll; "The present state of aeroplane construction," by Prof. Bendemann; "What health qualifications should be demanded of the pilot?" by Dr. E. Koschel; "The eyes of the aeronaut," by Dr. Halben; "The sources of the electrical charge of aircraft," by Dr. F. Linke; "The electrical properties of balloon materials," by Dr. Dieckmann. Hoffentlich (as the Teutonic idiom has it) the present upset in Europe will not permanently check the output of the class of literature of which this yearbook is a typical specimen.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject matter involved, or of the specialized, technical, or scientific knowledge required therefor.

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## SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, FEBRUARY 20, 1915

Charles Allen Munn, President  
Frederick Converse Beach, Secretary  
Orson D. Munn, Treasurer  
All at 361 Broadway, New York

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Scientific American Supplement	(established 1876) per year	\$5.00
Scientific American (est. 1845)	"	3.00
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